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THE MERSEY TUNNEL.

THIS great undertaking, which is now in complete working order, is of such general interest that we this week give a longitudinal section of the line from Lord street, Liverpool, to the Borough road station on the Cheshire side, together with several cross sections, showing the relative positions of the air and drainage headings; a section also of Green lane station showing the platforms, retaining walls and tunnel entrance. As visible in our engraving, the underwater portion of the Mersey railway consists of two slightly inclined lengths of tunnel of a collective length of about 2¼ furlongs and two steep gradients of about 2 furlongs on the Birkenhead side, and 1 furlong on the Liverpool side, the inclinations being 1 in 30 and 1 in 27 respectively, the total underwater length being about 1,232 yds. from sea wall to sea wall. Past the sea wall the tunnel continues at the same inclination to the James street and Hamilton square stations, beyond which at the Liverpool side the line is being extended under the town toward the Central station, at an incline of 1 in 31·33, and at the Birkenhead side toward Borough road at an inclination of 1 in 35 to 36. The surface of the rails at Liverpool in the James street station is from 85 to 100 ft. below ground, and the section of the tunnel is enlarged at the stations to 50 ft. 6 in. span by 32 ft. in height above rails, the length of the stations being 400 ft., and the gradient 1 in 100 for this distance. The tunnel proper has a width of 26 ft. and a height of 19 ft. above rail surface.

The stations are large, well lighted structures, into which entrance is effected by a short flight of steps leading from a lower hall, which forms the delivery platform of three hydraulic lifts communicating with the station at the ground surface. These lifts each accommodate about 100 people, and serve also as a means of communication with the engine and boiler department. At Birkenhead the boilers are placed on a floor separated about 30 ft. from the roof of the lower waiting hall by a solid mass of sandstone, which was, therefore, left untouched, the boilers being of Lancashire type set in brickwork. At the Liverpool side, however, the rock was found so much fissured that this 30 ft. of floor thickness had to be removed and a flooring of iron girders instead employed. On this account the boilers at the Liverpool end are of the marine self-contained type, and no brickwork is used in the seatings. The distance between the two stations, center to center, is about 2,000 yds., the working shafts being about 231 yds. nearer. The greatest depth of water at average high water is 100 ft., and at that point the tunnel crown is about 30 ft. below the river bed. From the foot of each incline beneath the water a heading for drainage purposes was run as far as the working shafts at each end at a slight incline shoreward. This served to keep the main tunnel clear of water during construction, as well as now acting in the same capacity. Besides the drainage heading, a loop heading for ventilation purposes runs alongside the tunnel from end to end, rising rapidly to the fan airways.

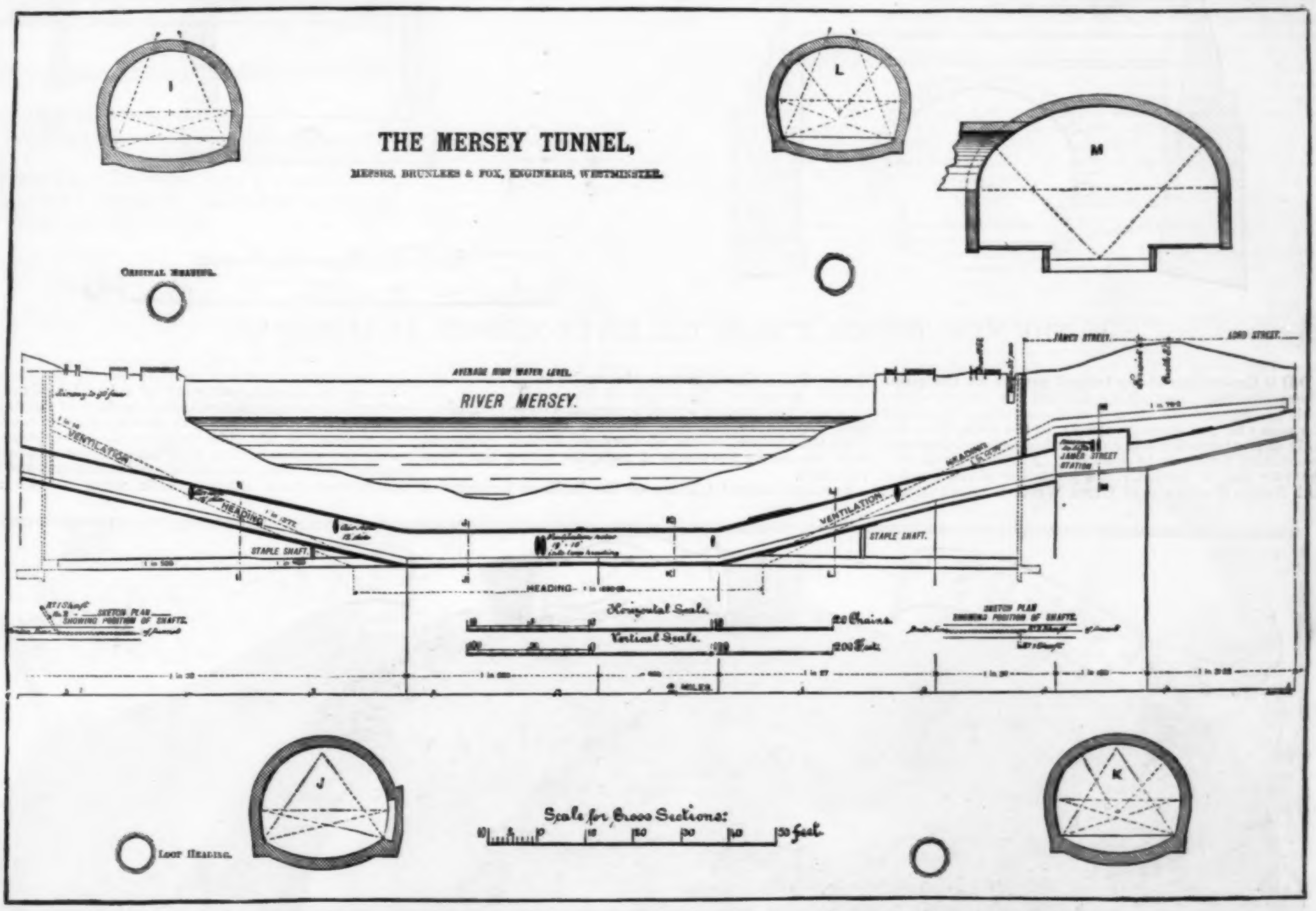
The fans are four in number, namely, two at each end, of 30 ft. and 40 ft. diameter. At each end the 40 ft. fan is employed in ventilating the tunnel proper, drawing air from the ventilation drift, which communicates with the tunnel at several points, as shown. By this arrangement all entering fresh air must pass in at the stations, which are always fresh and clear, and as the quantity of air dealt with by the fans in ten minutes is equal to the capacity of the tunnel, it is evident that the train service provided for is a very frequent one, as with a ten minutes' service the tunnel would be cleared of all smoke between trains. The 30 ft. fan on the Birkenhead side clears the tunnel between Hamilton street and Borough road, and that at the Liverpool side is intended to clear that portion beyond James street in the direction of Central station.

Messrs. Walker Brothers, of Wigan, are the makers of the fans, which are on the Guibal system, and they are considered fully equal in their collective capacity to half a million feet per minute.

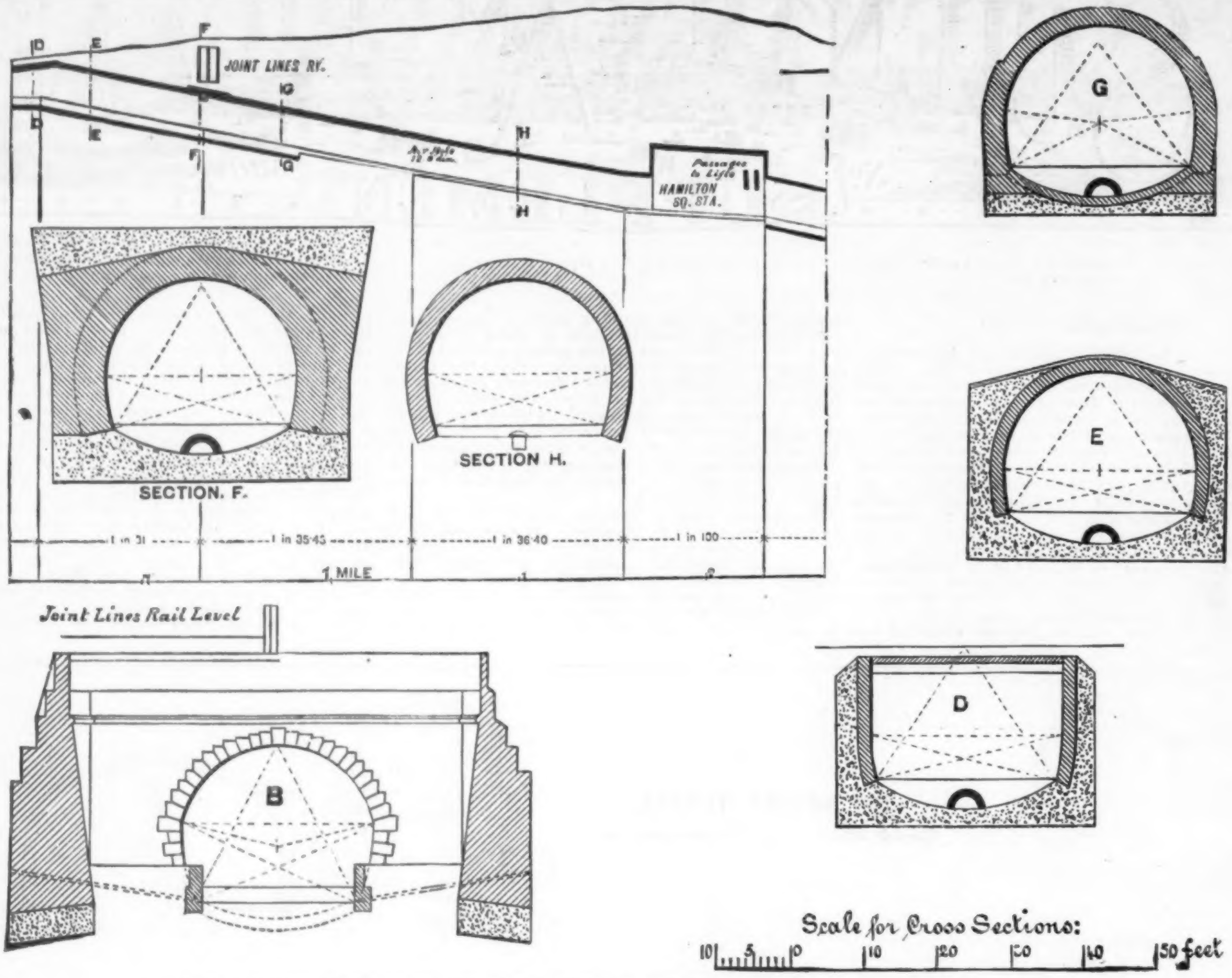
Among difficult engineering works the Mersey Tunnel does not hold a place, for, beyond the care necessary to secure correct alignment and level, no serious difficulties have been encountered. The tunnel has been excavated almost entirely in solid sandstone rock, but at one point it cropped out of the sandstone for a distance of a hundred yards, and the tunnel crown was here excavated to a height of four feet in overlying gravel and sand. Had it not been that this in its turn was overlain by a bed of strong bowlder clay, much trouble must have been experienced at this point from the accession of water. The clay prevented this, but to avoid rupture of the clay bed by the giving way of its gravelly foundation, special care was exercised at this point in timbering heavily to stay any possible roof movement. The Beaumont boring machine was used in forming the heading and also in forming the airway drift or loop heading alongside; and though great delays and disappointments occurred before the Mersey tunnel scheme assumed practical shape, the work, once commenced, went on uninterruptedly to the finish, which was just over six years from the date of commencement, December, 1879. The first operation after sinking the shaft was to run a trial heading from either side, and it is worth notice to remark that on the Liverpool side much made ground was passed through at the foot of James street before the old ground level was met with. The two headings were then driven forward at a slight rising gradient toward the center of the river, and thus kept the works dry, pumps, made by Hathorn, Davy & Co., of Leeds, having been put down at each end.

In September of 1881, two new shafts were sunk, so as to allow of one shaft being exclusively used for the pumping, while the other served for the output of spoil. As the driftway proceeded, the tunnel proper also was excavated, and as this had an incline toward the river center, bore-holes were made between the tunnel floor and the driftway beneath, and so kept the face of the work dry. The driftways met in January, 1884, and much of this progress is considered due to the Beaumont boring machine. The tunnel was enlarged at several points in the course of the driftway, and bricked up with six, seven, and eight rings of blue Staffordshire faced brickwork. To warrant such a proceeding in face of the fact that a base line for the alignment of the tunnel center could only be obtained of a length of four yards, and that in a shaft not in the center line of the tunnel, the greatest care was exercised in the instrument work, and the confidence reposed in this work was justified by the result, which was practically accurate, a deviation less than 2 in. only being all that was made between the drifts from both sides. As visible from our engraving, the tunnel section is considerably varied according to requirements necessary, the cross sections varying in different portions of its length according to circumstances.

Section B B is from a portion of the line not shown in our drawings, namely, Green lane station, at 2¾ furlongs from the junction of the Mersey railway with the London and North-Western and Great Western joint line. The section shows the station platform, here open to light though considerably below ground level, and the form of tunnel entrance with section of retaining walls upon concrete foundation.



THE NEW TUNNEL UNDER THE RIVER MERSEY, AT LIVERPOOL.



THE NEW TUNNEL UNDER THE RIVER MERSEY, AT LIVERPOOL.

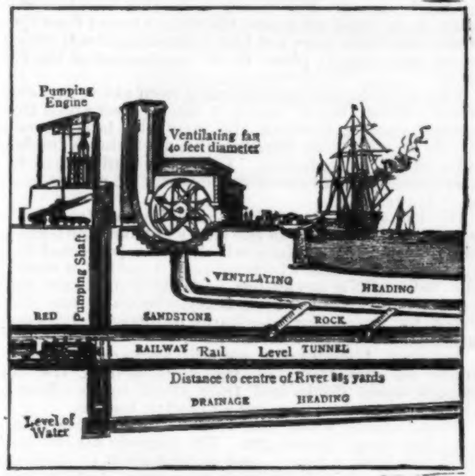
D D is the section of the tunnel proper at the point where the falling gradient toward the river may be said to commence. Its flat roof continues for a short distance only, changing rapidly to the form E E, the body of the tunnel being so near the surface being well re-enforced by concrete backing. Further on at F F, the line passes beneath the joint line of the London and North-Western and Great Western railways, and the section is therefore very strong for as hort distance, as the weight of the overhead line comes upon the crown of the tunnel, which is carried well out laterally and covered in concrete. Section G G, still not far from the surface, is still of stronger section; while at H H, where the bottom is of rock, no invert has been required.

Sections I I and L L are of the inclined portions of the underwater portion of the tunnel, showing the drainage heading below, while at J J and K K are two sections of the almost horizontal portion of the tunnel, showing the loop heading or airway, and in section J the recesses in the side walls are places of refuge and safety for workmen, and tool depositories. It will be noticed that from the middle point beneath the river the tunnel falls slightly both ways to the steep

THE NEW TUNNEL UNDER THE MERSEY RIVER, BETWEEN LIVERPOOL AND BIRKENHEAD.

gradients, because for this length the tunnel forms its own drain, and the invert is of greater depth than elsewhere in the underwater length. Beyond the part of each gradient, however, the whole of the drainage from the tunnel is conducted by the lower drainage drift to the pumping shaft on each shore, where it is dealt with by the pumping engines. The amount of water percolating is very small, and it is probable that this will decrease under the operation of the well-known natural silting process, which is found to fill rock crevices with clayey matter from upper strata in cases where the percolation is so slight as not to amount to a scour. With a tunnel lined with blue brick, and pierced through solid rock, such percolating water must leave all clayey matter outside the tunnel, so that in time it may become quite dry throughout. At M M, the section is shown of the James street station, showing the openings to the lower waiting hall.

We show also two small sketch plans, showing the position of the two shafts at each side of the river. For



The Ventilating Fan draws the Air under the River at any Desired Point.

SECTION SHOWING RELATIVE POSITION OF RAILWAY TUNNEL, DRAINAGE AND VENTILATING HEADINGS.

anything else the drawing (for which we are indebted to Messrs Brunlees & Fox) is self-explanatory.

The three lifts at each end have been constructed by Messrs. Easton & Anderson, of Erith, Kent. The lifts at James street have a rise of 76 ft. 6 in., and those at Hamilton square of 87 ft. 6 in. At each station is a tower containing a tank 120 ft. above pavement level, for the purpose of working the lifts. These tanks, which were not yet in operation at the date of our visit, before February 1st, contain 10,000 gallons of water, and the waste-well is placed 60 ft. below pavement level.

The rams, one to each lift, have a diameter of 18 in., and are of steel—hollow. The cylinders are sunk in bore-holes cut in the solid rock, and of great strength, and each lift cage—which is a room 20 ft. by 17 ft., very well gotten up in teak and ash—is carried on the ram head by means of a framed floor of iron girders. Suitable guides are placed in the shaft to guide and steady the cage, and balance weights hung over overhead pulleys by heavy chains counterbalance the whole to such an extent that the lift will descend with the weight of one man. At the time of our visit the lifts were worked directly by the engines, which consist, at James street, of three pairs of Easton & Anderson's "Duplex" patent, and at Birkenhead of two pairs, the boilers being, as above stated, of marine type at Liverpool, and of the ordinary Lancashire type at Birkenhead.

The resident engineer for Messrs. Easton & Anderson was Mr. C. R. May.

The company's engineers are Mr. Brunlees and Mr. Charles Douglas Fox, Mr. A. H. Irvine being resident engineer. The contractor is Mr. Waddell, of Edinburgh.—*Mechanical World.*

Mr. C. Douglas Fox, Engineer to the Mersey Tunnel. Mr. James Brunlees, Engineer to the Mersey Tunnel. Mr. A. H. Irvine, Resident Engineer, Mersey Railway.

ENGINEERS OF THE NEW MERSEY TUNNEL.

LONG DISTANCE TRANSPORTATION OF NATURAL GAS.*

By THOMAS P. ROBERTS.

MY proposed method of gas transportation is simply, the adaptation of the exhaust system as employed to ventilate mines. I would not, with my present light, in case of adopting a sheet iron pipe, propose to exceed five feet in diameter, nor urge it when of that size to deliver more than 1,000,000 cubic feet per hour, at or just under normal pressure. The velocity in this case should be maintained at about 10 miles an hour. I was somewhat surprised to find that this proposed size of gas conduit is exactly that prescribed by the laws of Pennsylvania for the intake of air shafts for anthracite mines, no matter what was the extent of the working. This size has never been proved insufficient to supply the requisite volume of air, and a 20 horse power fan at the exhaust shaft is generally more than sufficient to draw in over 1,000,000 cubic feet of air per hour.

The diagrams on the board illustrate a system of exhausting and propelling the gas by the application of heat, that is, by contrasts of temperature alternately condensing and expanding the gas. I am not afraid, when the circulation is once established in a given direction, no matter how feeble, that the expanded gas will display a tendency to work back against a denser medium.

It will assuredly seek the direction which presents the most favorable conditions. The location of these heating stations, or exhaust fans, there being but little difference in the effectiveness of the methods on a long line of pipe, would be determined by circumstances. Experiment would discover the points where there was a tendency to accumulation of pressure. Atmospheric conditions might have something to do with this in case of an exposed pipe—a warm sunshine at one point contrasted with clouds and coolness at another point on the line; or possibly over a mountain a pneumatic exhaust or gas siphon would have to be permanently maintained by heating and rarefying the ascending gas in one, and cooling and increasing the gravity of the gas on the other side. But with the confidence I have in figures made up from reports of mine-ventilation under more trying conditions, I believe that the intervals between assisting stations will not ordinarily be more than 20 miles. The equivalent of a 20 horse power engine every 20 miles is insignificant as compared with the cost of pumping gas on the high pressure system.

PUMPING GAS.

I will not detain you with figures on the pumping plan, but it can easily be shown that to gather up 1,000,000 cubic feet of normal gas per hour and pump it at 200 pounds pressure would require an hourly plunger capacity of 75,000 cubic feet at the delivery end. Two of our gigantic Negley Run water works engines, working together, are not quite equal to the task. Two of these working with two in reserve at intervals of every fifteen miles would do the work, provided they did not blow up the pipe joints. Flexibility of the pipes must be secured before any system is perfected. This seems altogether impossible in any plan of jointed pipe.

It is reported that several years ago the six inch main supplying Spang, Chalfant & Company's rolling mill proved insufficient to supply them with gas. Several pumping experiments resulted in failure. Finally, a special Cameron pump, made for the purpose, was tried. This pump had a forty-inch plunger with four foot stroke. It took the gas at a 30 pound pressure, but although in a fit of desperation the machine was worked to 250 revolutions per minute, the main at its delivery end exhibited 15 pounds pressure. The engine actually obstructed half the flow of the gas. The story is detailed as the truth; but whether true or not, the pump makers have preserved a remarkable silence of late.

NATURAL FLOW.

According to a formula handed me by a friend, expert in gas calculations, a pipe of five feet in diameter will discharge 1,000,000 cubic feet per hour at the end of 100 miles, with an initial pressure of 2·56 pounds.

$$h=\frac{q^2 s\, l}{(1350)^2 d^5}$$

In which q is quantity, s specific gravity (0·55 in this case), l length in yards, d diameter in inches.

In this example we have a total initial constant pressure of 7,234 pounds, and a velocity of about 15 feet per second—which would be equivalent to about 197 horse power. I would not advise this system. Any pressure in a large conduit, much above the normal, involves great expense for pipes and joints. If 197 horse power per hundred miles were required, I would divide the power among a number of smaller engines, stationed at intervals along the line, solely for the purpose of effecting the enormous saving which flexible sheet iron pipes would permit of in the cost of pipes.

I will call your attention to the cement-lined brick underground, or, as it may be in some cases, half underground, conduit. After a certain limit, it would no doubt be cheaper than sheet iron. It has other advantages also, which I need not dwell upon. In the crossing of ravines or valleys, rivers, etc., it could be carried on light trestles in one large sheet-iron pipe, which could be strengthened by longitudinal compartments.

I need not detain you with figures of cost in detail, except that I have estimated that a five-foot main constructed of iron as heavy as No. 14 gauge—about the thickness employed on the largest steamers for their stacks—would cost, complete per mile, about $14,000. In this I think there is margin enough for right of way. To furnish 24,000,000 cubic feet of gas daily to, say, Philadelphia, with, say, 335 miles conduit, would cost $4,550,000. With the distribution system and contingencies the outlay would probably be not less than $6,000,000 to reach even "the cream of the trade."

As for income, the gas could certainly yield 10 cents per thousand, making $700,000 per annum. Allowing for maintenance and renewals, there should be enough for a fair dividend.

Of the ten thousand coke ovens in the Connellsville region, probably 3,000 are charged daily. A charge of coal averages about five and a half tons, which, for the region, would make a total of 16,500 tons daily. At the rate of 4 cubic feet of gas per pound the product for one oven would be 44,000 cubic feet, and for the region 132,000,000 cubic feet of gas daily wasted in the atmosphere. Of this, possibly seventy-five per cent. or 100,000,000 cubic feet of gas daily could be profitably utilized for heating purposes if means could be found for transporting it. In this case, at least, there is no reason to doubt the permanence of the supply of gas, and therefore projects looking toward utilizing it possess the most absorbing interest, not only to the engineer, but to the capitalists as well; and when these cast their eyes through a large low pressure conduit, through which the gas is to be drawn by means of fans or other contrivances on the exhaust principle, they will see the way clearly.

It would probably not be practicable in a distributing system to furnish gas at a pressure verging on the normal, therefore condensing machinery, possibly more powerful than fans, would have to be employed at the terminus of a low-pressure main conduit. The limit of fan pressure would be reached at between six and seven ounces per square inch, and on some distributing lines it would be desirable to have as much as five pounds pressure per square inch.

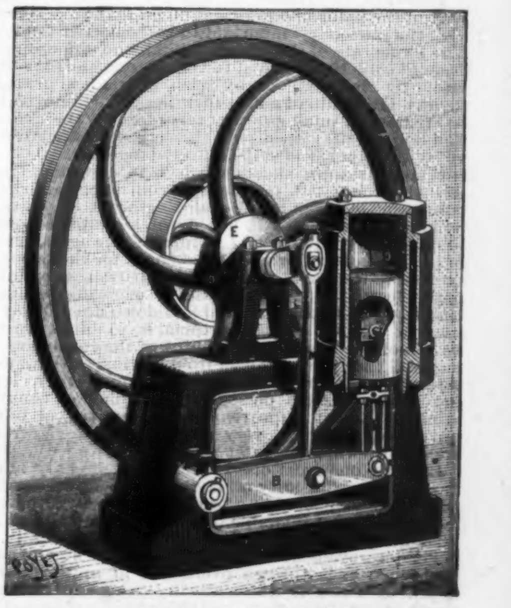
A recent number of *Engineering* describes a new blowing engine built in England, to be sent to Liker, Hungary. The engine has two steam cylinders (compound), 3 feet 7¾ inches and 5 feet 5 inches diameter respectively. Blowing cylinder 7 feet 6⅝ inches diameter, stroke in all 5 feet 7 inches. Twenty-five revolutions per minute. This engine draws 23,000 cubic feet of air, and condenses it to six pounds pressure per minute. Horse power, 620. This engine would be therefore more than sufficient to condense 1,000,000 cubic feet per hour of normal gas and deliver it at five pounds pressure.

* Abstract from a paper read before the Engineers' Society of Western Pennsylvania, January 19, 1886.

BENIER'S VERTICAL GAS ENGINE.

THE gas motors constructed by Mr. Benier are designed for the production of low motive power. The most powerful of them do not develop a power of over four horses, while the smaller sizes (one of which is shown in the engraving) develop, respectively, one eighth, one-fifth, and one-third h. p. at velocities of 140, 130, and 120 revolutions per minute.

The arrangements peculiar to this model have been combined with the object in view of rendering the motor easily set up, started, stopped, and run by any one whatever, such being indispensable conditions in a motor of low power, to which an active and continuous surveillance cannot be devoted.



BENIER'S GAS MOTOR.

As regards the principle of its operation, the Benier motor is a simple acting one, without compression. The mixture of air and gas enters the cylinder, during a certain fraction of the stroke, at the pressure of the atmosphere. An inflammation is then effected, the pressure rises to four or five atmospheres, and an expansion is produced up to the end of the stroke. There is therefore one motive stroke per revolution at the time of the piston's descent. The piston rod acts through compression, and the connecting rod that actuates the crank of the driving shaft acts through traction. An explanation of such action may be found by referring to the cut. It will be seen, in fact, that the connection of the piston and connecting rod is not direct, but is effected through the intermedium of the working beam, B. This mechanical arrangement possesses the following advantages:

(1) It reduces the oblique action of the connecting rod upon the piston, in a large measure, and thus prevents an ovalization of the cylinder. (2) The point where the working beam and connecting rod are jointed is so selected that a lighting shall occur at the moment at which the radius of the crank is at right angles with

the axis of the connecting rod. The result is that a maximum pressure is exerted at the moment at which the shaft possesses the greatest velocity. (3) The use of a working beam and two parallel connecting rods, one actuated by the piston and the other acting upon the crank, reduces the dimensions and weight of the motor, which thus becomes very compact, and so much the more easily set up.

The system of distribution consists of a slide-valve with several orifices controlled by a cam, D, against which it always remains pressed through the action of spiral springs. Properly distributed ports secure an introduction of the gas and air, as well as the lighting through a small burner. The expulsion of the products of combustion during the return of the piston is effected through a valve, which is lifted by a cam, E. Cooling is effected by means of a circulation of water in a double jacket.

The water used for this purpose is, moreover, always the same, it being continuously led back to a reservoir, in which it cools. A capacity of 44 gallons is sufficient for motors below ½ h. p. This cooling through a circulation of water is a complication (especially for motors of low power) that has been skillfully suppressed in the Bishop and Forest motors, in which the cooling is done by the surrounding air. The consumption of gas in the ⅛, ¼, and ½ h. p. types is respectively 14, 21, and 26 cubic feet per hour.

The types of larger size, which are designed to develop a power of 4 horses, differ from the smaller ones merely in details. The cylinder is placed in the center of the frame, and the shaft is cranked, instead of a terminal crank being used, as in the model shown in the figure. The consumption of gas is 49 cubic feet per hour in the one horse power motors, and about 42 in the four horse ones.

This motor is especially adapted to the needs of cutlers, sausage makers, grocers, bakers, printers, pastrymen, etc., and, in a word, to those of a certain number of manufacturers who utilize low motive power at intervals, and who like to have at hand a simple and strong apparatus, and one that is always ready to operate.—*La Nature.*

THE USE OF TORPEDOES IN WAR.*

By Commander E. P. GALLWEY, R.N.

IN accordance with the wishes of the Council of the Royal United Service Institution, who did me the honor of asking me to read a paper on the subject of "The Use of Torpedoes in War," I have endeavored to present to you, as clearly as I am able, the present state of efficiency of this weapon, and the degree of perfection which it has now reached.

As the time to which I am limited is insufficient to do full justice to my subject, I will, in the few remarks which I shall venture to offer, confine myself principally to those torpedoes which are in ordinary use in all naval services.

Before, however, we proceed to discuss the probable value and importance of the torpedo either as an offensive or defensive weapon in naval warfare, it would, I think, be as well for me to preface my remarks by describing briefly those torpedoes which are likely to play a prominent part in any future naval war, and to state the degree of perfection which they have now attained.

There are two classes of torpedoes which now form part of the fighting equipment of the majority of ships, viz., the stationary mine and the locomotive torpedo. The former are of the simplest kind, and are ordinary cases of explosives moored to the bottom, and exploded either by electricity or by some mechanical arrangement. Each ship of a fleet carrying these mines is able to lay down a small group of torpedoes for the defense of a harbor, the efficiency of the defense being governed by the number of ships collected together.

If circumstances compel the fleet to leave some harbor which has not previously been defended by the submarine mines of the Royal Engineers, they would be able before leaving to lay down a complete system of mines very rapidly, and to intrust the actual firing of the mines to a few men left behind for the purpose, or even to the care of some local person acquainted with electricity. Another use of mechanical mines, that is, those that being once laid down are difficult to remove without exploding them, is to block up the mouth of harbors in which ships of the enemy are lying, and thus prevent them from leaving, without considerable danger to themselves, until they have previously cleared a passage by sweeping or countermining. Recent improvements in mechanical mines have rendered this a very likely and, indeed, certain method by which fleets will be harasse

Hitherto one great disadvantage of stationary mines has been the difficulty of laying them down so that they shall be moored at a proper depth below the surface. It takes considerable time, and it is an almost impossible operation at night to moor them efficiently.

The improvement referred to is to so fit the mine that when it is thrown overboard in any unknown depth of water it automatically takes up its right depth below the surface, and this result is obtained by a very simple arrangement, and one that is unlikely to get out of order. It was first invented by Lieutenant Pietruski, of the Austrian Navy, and has been largely adopted by several foreign powers, more with the idea of quickly defending harbors with it, but still with the object also of using it to blockade an enemy in his own harbor.

These mines can be used in a fast torpedo boat, which, steaming rapidly across the mouth of a harbor, would drop them at regular intervals, and thus form a perfect line of defense, which would effectively bar the ingress or egress of a ship until they were removed.

The details of the Pietruski mine are kept secret, and though we have a very similar one in England, which was invented by Lieutenant Ottley, R.N., I am unable to enter into the details of its construction.

Although these electrical and mechanical mines may at times be of great value, it is unlikely that they will have any very great influence one way or another in determining the result of a naval war, so I propose to pass on to locomotive torpedoes, which in my opinion must exercise a decided influence on all future naval operations.

Foremost among them is the Whitehead torpedo; in fact, there is no other which can compare with it in efficiency. As every nation takes up the Whitehead, so they gradually leave off the use of the outrigger, the towing torpedoes, and others. I am strongly of the opinion that the outrigger torpedo should be entirely abolished in all modern fleets, as presenting a very small chance of success, and interfering with the use of a more efficient weapon.

It is to the Whitehead torpedo, therefore, as being by far the most formidable, and also that most generally adopted by all navies, that I wish especially to call your attention.

Diagram 1, Figs. 2-7 (Plate I.), illustrates the various forms of the Whitehead torpedoes now in use, and I am also able, through the kindness of Count Hoyos, Mr. Whitehead's partner, to show you a sketch of the first model, from which the idea of a locomotive torpedo originated, and also to give you a short history of the invention. In 1864 Mr. Whitehead entered into an agreement with a certain Captain Lupuis to work out and improve an idea which the latter had conceived of a fire ship designed to run on the surface of the water, and to be steered by means of ropes led to each side of its rudder from the shore.

Fig. 1 is a drawing of the model which was made to illustrate his idea. In this model, motion was given to the screw by means of clockwork, and the steering was effected by a rudder which was worked by small ropes from the shore. The forepart was filled with gunpowder, and the explosion was effected by means of a pistol placed in the head of the ship, the trigger of this pistol being in communication with a movable blade at the bow, and with one vertical and two horizontal spars; so that if any of these arrangements came into contact with the object aimed at, the pistol was fired, and the charge exploded.

Though Lupuis' fire ship has really nothing in common with the Whitehead fish torpedo, it was the idea from which the latter has germinated. Mr. Whitehead, after two years' work, in which he was assisted by his son, then a boy of twelve, and a trustworthy workman, produced the first fish torpedo. It was made of a boiler plate, and carried 18 lb. of dynamite, and had a speed of 6 knots for a short distance. In June, 1870, the English Government took up the matter and carried out a series of experiments. These experiments proving successful, in April, 1871, the Government purchased the right to use the invention for £15,000, the torpedo as it then was being shown on Diagram 1, Fig. 2.

Fig. 3 shows the form, etc , of the torpedo in 1876, its speed being then increased to 20 knots.

Figs. 4 and 5 show two later patterns, one 19 feet long, and the other 9 feet 6 inches.

The longer one is principally used from torpedo boats and submerged forts. Its use from boats is advocated by many officers, who say that it will be very formidable against ships at anchor, as its great range of 850 yards would in many cases allow you to get a successful shot before the boat was discovered, as numerous experiments have proved that it is often impossible to see a boat beyond this distance, and that, if seen, the fire of machine guns is very uncertain at this range.

A ship, of course, offers a very small target at this distance, and no doubt if possible you ought to get very much closer. But there are many cases which I have seen in sham attacks in which a fleet has anchored, and then swung in such a manner that a continuous target of at least half a mile in length was presented, and through which the torpedo could hardly pass without striking one of the ships. The great length of this torpedo, however, makes it a very unhandy weapon for a boat, besides which, its extra weight limits the number which can be carried.

For forts, however, it is very valuable; I would even go to a larger size, and thus increase either the speed or the range.

Diagram 2 represents a submerged discharging apparatus in a fort suitable for this class of torpedo. The torpedo fired under these conditions is more reliable than under any other, as it starts at nearly the same depth below the surface it is adjusted to run at. Under these favorable circumstances it is quite reliable up to 800 yards, and may, I think, always be depended on in tideless waters to pass under a target 30 feet long at that distance.

The smaller torpedo, 9 feet 6 inches, is for use from boats or small ships, and is likely to come into very extended use for circumstances in which economy of weight and space are an object.

Mr. Whitehead's latest pattern is one 14 feet long, and is not shown on these diagrams; it has a speed of about 25 knots for 433 yards.

Fig. 6, Diagram 1, is the German torpedo made by Messrs. Schwartzkopff at Berlin. It is made entirely of phosphor-bronze, and is an almost exact copy of Mr. Whitehead's.

The adoption of phosphor-bronze for the whole of the torpedo has many advantages, the principal one being that it enables a torpedo, after being adjusted at the works, to be sent to sea without being again taken to pieces for cleaning, an operation which often, with steel torpedoes, affects their accuracy, unless it has been done with great care. The German torpedo is of excellent workmanship and extremely accurate; for instance, in 60 shots taken at Kiel the other day, the mean error in direction at 400 meters was 2·4 meters, and the depth was always within a small decimal of that at which the torpedo had been adjusted to run. These phosphor-bronze torpedoes have been kept for three consecutive weeks in the water ready for running, and at the end of that time have run perfectly. One of the uses which the German Government proposes to put them to is to tow out and sink a sort of caisson (containing a number of these torpedoes in it) in the middle of a channel, pointing in a known direction, and to start the torpedoes by means of an electric wire led from the shore, and so practically to increase their range.

The use of phosphor-bronze, for the whole of the torpedo, appears, however, to entail a loss of speed. The air-chamber should therefore be made of steel, but all the working parts of phosphor-bronze. When this is the case, the torpedo need seldom to be taken to pieces, but of course it cannot be kept submerged for weeks without deterioration, but this is not so important a point as speed.

Fig. 7 shows the form of the Woolwich torpedo. This has a speed of 24 knots for 600 yards, and carries a charge of 70 lb. of gun cotton.

When the first torpedo was introduced, it was never intended to be used from above water, but to be launched from a tube projecting through the stem of a ship below water. For this purpose the torpedo would not require to be of any great strength, as but little strain is brought on it while being ejected. With the introduction of the plan of firing from above water on the beam of ships proceeding at high speed, it was found necessary to make the torpedo very much stronger. Improvement in this respect, and also in the engine power, has been the direction of most experiments to improve the weapon. The torpedo has also been greatly improved by simplifying the various adjustments necessary. In fact, with the later pattern torpedoes there are no adjustments which cannot be made weeks before the torpedo is used, so that it can be supplied ready for use, and all the crew have to do is to load the tube and fire it; if the working parts are made of phosphor-bronze, the torpedo can be returned into store after practice, without altering any of its adjustments.

A very large number of shots are fired every year in our navy, and the number of injuries to the working parts, which used to be rather numerous, is now exceedingly small. For instance, in 1883, besides about 1,500 shots fired at home, the ships abroad fired 1,164 shots, and there were not half a dozen accidents reported to have taken place to the mechanism of the torpedo.

The torpedo can be discharged from above or below water. From below water, it can be discharged from a tube passing through the stem, the latest form of which is shown on Diagram 3, which shows the bow tube of the Polyphemus. Very successful practice has been made with a tube of this description up to a speed of 18 knots.

On the beam the torpedo can be fired from below water through holes in the ship's bottom, the torpedo being supported by bars which can be projected from the ship's side, and which support it until it is clear of the tube. This device has, as far as I am aware, only been tried in the English Navy, the numerous ships fitted for submerged discharge in foreign navies only firing ahead in line with the keel.

Diagram 4 shows the general arrangement of the tubes on the beam of the Polyphemus, the torpedoes being discharged from them by an officer in the conning tower pressing an electric button.

From above water the torpedo is launched from a tube known as the air-gun. The torpedo fits this tube with but little windage, and is blown out by means of compressed air admitted at the rear. Lately, gunpowder has taken the place of compressed air in many foreign ships, and no doubt the use of an explosive will become the general means of discharging a torpedo, as it enormously simplifies the discharging apparatus and lessens the chance of failure. Now that the torpedo is simplified to the extent that no adjustments need be made to it in action, and that it has only to be launched into its tube, a charge of gunpowder hung on the door and the door closed, the objections that used to be raised on the score of complications seem to be quite overcome.

Diagram 5, Plate II., shows a modern tube mounted on the side of an ironclad, the tube being able to train through a large arc.

The advantage claimed for above water discharge over below is that the former is the simplest of the two; but the latter has the advantage of keeping the men under cover, and the torpedo deflects less when entering the water.

Before the value of the torpedo can be justly estimated, it is necessary to take into account the various errors which may occasion a lost shot.

The first error which may be introduced is when firing from the beam of a ship, if the correct deflection due to the angle at which the torpedo enters the water is not allowed. This deflection is usually about one degree per knot of speed of ship, but it varies slightly according to the position in which the tube is placed. From below water on the beam the deflection is very small, while right ahead it does not occur.

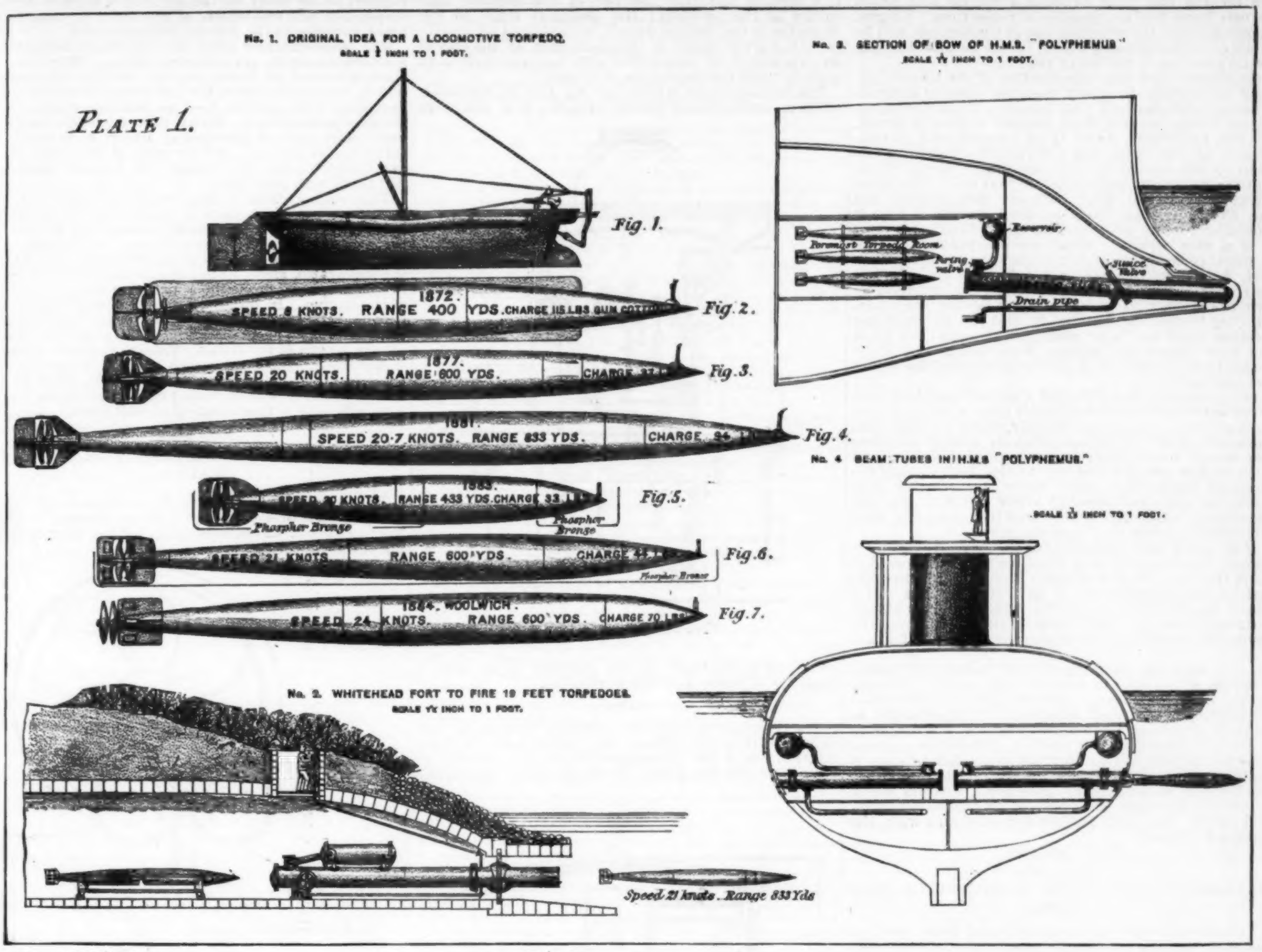
Another error which must be taken into account is that due to the speed of the enemy being wrongly estimated by the officer firing the torpedo. Diagram 6 shows the amount of error which may be introduced on this account without resulting in a lost shot. This diagram represents the Edinburgh steaming at 15 knots on a straight course, being fired at by a torpedo boat, T, with a 20 knot torpedo. In order to strike the Edinburgh amidships at 300 yards range, the torpedo must be fired at a point, X, when the Edinburgh is at A, in which case they will meet 26·6 seconds after the torpedo has been fired. If, however, the Edinburgh, instead of 15 knots, were really going 18½, her center would have arrived at X' in 26·6 seconds, and she would be just struck on the stern, or if she were only going 11½, her stem would be struck; so that the amount of error which may be allowed on each side of the true speed of the Edinburgh under these conditions would be 3½ knots each way, and if the speed had not been judged between these limits, she would have been missed.

The faster the torpedo, the less chance there is of the speed of the enemy being so badly estimated as to cause a lost shot. It is reasonable to suppose that in another year or so the speed of the torpedo will have increased to 30 knots; in fact, at the present time a torpedo has run 27½ knots. At the present time, however, the distance at which the modern torpedo may be considered as thoroughly reliable is, I think, 300 yards when firing at a ship in motion, and 400 at a stationary object.

The types of vessels from which the torpedo will be used are: ironclads and other large vessels; special torpedo ships; and torpedo boats.

And now I will draw attention to the subject which I hope will prove the main point of discussion this afternoon, viz., what is the probable value of the torpedo in a fleet or single-ship action? Will it supersede the gun and ram, or either of them? I am aware that whatever opinion is expressed, it is open to the retort that it is all conjecture, for it has never been tried in action. But this argument can be applied to all or any of the modern weapons in a man-of-war. The arguments in favor of the Whitehead being successful are that out of an enormous number of shots fired in practice, the greater number run well, that if it does strike it will either disable or destroy the enemy, that with the torpedo you are not obliged, as with the ram, to engage in an encounter in which a slight error in judgment on the part of the officer in command may cause the loss of his own ship, and that he will not have to

* A lecture delivered before the Royal U. S. Institution, March 6, 1886.



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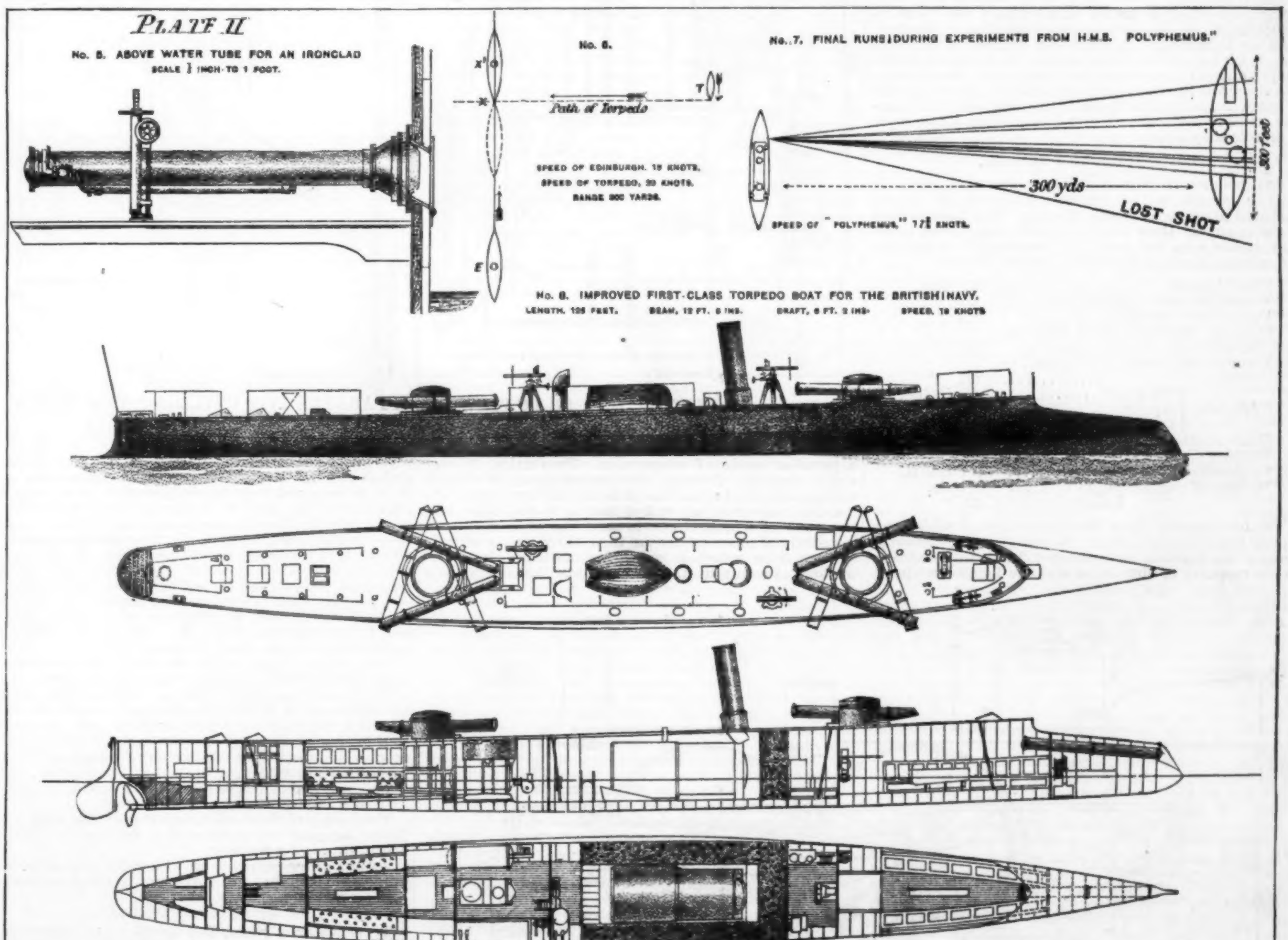


THE USE OF TORPEDOES IN WAR.

use for the first time in action a weapon with which he can have had no practice in peace time. I argue, therefore, that the principal use of the torpedo will be in those circumstances which, before its introduction, would have led to the use of the ram.

Especially does the introduction of the torpedo appear to increase in many cases the value of accurate shooting with the guns; for instance, if you are engaging an enemy weaker than yourself in guns or armor, do you not throw away these advantages if you approach him so close that you risk an attack by a torpedo on the bottom of your own ship, a part in which you are as equally vulnerable as your foe? The latest naval action, viz., that between the Huascar and the Cochrane, has been so often described that it would be wasting your time for me to do so here. But it is a case certainly which seems to point to the immense superiority which the torpedo has over the ram; and, indeed, in this case not only over the ram, but also over the gun. Here is a small vessel set upon by two ironclads, who pound away at her for two hours, who try to ram her continually, and yet, although her steering gear was shot away, fail signally; yet when she surrendered, her engines were intact, and if she could have steered, it is not unlikely that she would have escaped.

Is it possible to suppose that if either vessel had been fitted with torpedoes below water they would not have been able to use them successfully, when we read from the accounts of eye-witnesses that on several occasions the vessels were within 50 yards of each other, and once within 10; and that up to the last, though the Huascar was riddled above water, her steering gear gone, her guns and conning tower disabled, she was practically uninjured below, and her engineers were able to obey orders and work the engines?

If ramming were hazardous to the ship attempting it before, it is doubly so now when we take into consideration the large number of ships fitted to fire a torpedo right astern or nearly so. A miss with the ram and a shave under the enemy's stern will nowadays almost certainly result in a stern torpedo being fired from the enemy under the most favorable circumstances for that weapon.

I look upon the submerged bow discharge (Diagram 3) as one of the most important positions for a torpedo tube. From the bow the torpedo leaves undisturbed by passing water, and hundreds of experiments in ships of all nations have shown that the most accurate practice is made from this position. I therefore contend that the torpedo has now arrived at a sufficient state of perfection to make it unwise for any one to attempt to use the ram, so long as he possesses a weapon which practically increases the length of his ram to 300 yards, and can be used with greater certainty and with less danger to himself.

(*To be continued.*)

ESTRADE'S HIGH-SPEED LOCOMOTIVE AND CARS.

Convinced that, in the question of high speed on railroads, as in so many others, no reasoning can hold its own against facts, Mr. Estrade is having constructed, of full size, a system of rolling stock of which he had already deposited a model on a scale of one-tenth in the galleries of the Conservatoire des Arts et Metiers. This is a bold tentative, upon the success of which it would be hazardous to pronounce in advance of the trials to which it is soon to be submitted. The inventor's idea consists in making general the use of wheels of large diameter, in extending the coupling of locomotive axles to high speeds, and in adopting a new style of double suspension.

LOCOMOTIVE AND TENDER.

The locomotive, Figs. 1 and 2, is provided with six driving wheels of the common diameter of 8¼ ft., mounted upon three coupled axles. The total weight of the engine is thus used for adhesion. This, moreover, is the sole, but essential, peculiarity of the motor, whose principal dimensions are as follows:

Lotal length		33	feet.
Width between longitudinals		4	"
Diameter of wheels		8¼	"
Distance between axles, hind to middle		8½	"
Distance between axles, middle to fore		8¾	"
Cylinders,	diameter	18⅛	inches.
	stroke	27⅛	"
	from axis to axis	6⅛	feet.
Grate surface		24¾	sq. feet.
Heating surface		1,408	"
Capacity of boiler		144	cubic ft.
Weight of engine, empty		38	tons.
" " loaded		42	"

The high speeds (72 to 78 miles) in view of which this engine has been built have, as may be seen, caused as great a development as possible of the elements relative to the capacity of the boiler and the heating surfaces. It is here, in fact, that lies one of the greatest difficulties of the problem: the practical limit to the diameter of the driving wheels, necessitated by stability, being given, speed is obtained only at the cost of an expenditure of steam that soon becomes such as to quickly "put the engine out of breath."

The tender, whose wheels are 8¼ feet in diameter, offers no arrangement worthy of note; it is simply so contrived as to permit of the carriage of as large a quantity of water and fuel as possible.

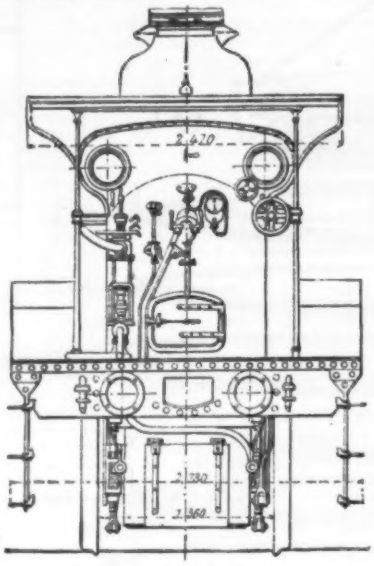


Fig. 2.—REAR VIEW.

CARS.

The passenger car presents very few features in common with those in ordinary use. Independently of the distribution of the compartments into two stories, we remark, in the first place, the use of 8¼ ft. wheels, and a peculiar mode of suspension. Two axles, 16 feet apart, support, through the intermedium of elliptic springs mounted upon the oil boxes, an iron longitudinal that runs from one end of the car to the other, and the ends of which curve toward the ground. Each longitudinal piece carries in turn three other elliptic springs, from which is suspended, through the intermedium of iron rods, the lower frame that serves as a support to the body of the car. It is, then, a double suspension, and one which, at first sight, appears to be much superior to the systems hitherto tried.

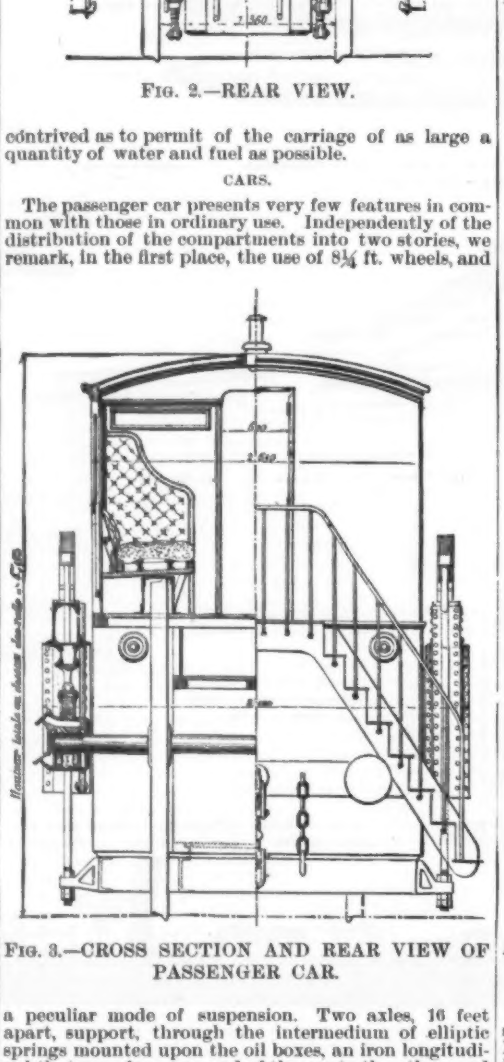


Fig. 3.—CROSS SECTION AND REAR VIEW OF PASSENGER CAR.

The large diameter given the wheels has necessitated a separation of the car into two stories. The lower of these is formed of three pendent sections with doors, which, toward the axles, are prolonged by narrow compartments that may be used as baggage rooms, wash rooms or water closets. Above, there is a single compartment, with central passageway, which is reached by stairways at the end. All the cars of the same train are connected at this height by hinged platforms furnished with hand rails.

This rolling stock is now nearly finished, and Mr. Estrade proposes to have it tried upon the southern lines. Through the unusual dimensions given the driving wheels, he has endeavored to increase the speed without increasing the expenditure of steam in the same ratio, since, from the standpoint of power, he desires to put to profit the adhesion of the total weight of the engine. In order to diminish friction, he has provided the cars with the same wheels, and has also elongated them as much as possible in order to diminish the length of the trains. Finally, through a double suspension, combined with less circumferential velocity, he hopes to considerably lessen those shocks of every nature which, with present velocities, render long journeys so fatiguing.—*Le Genie Civil.*

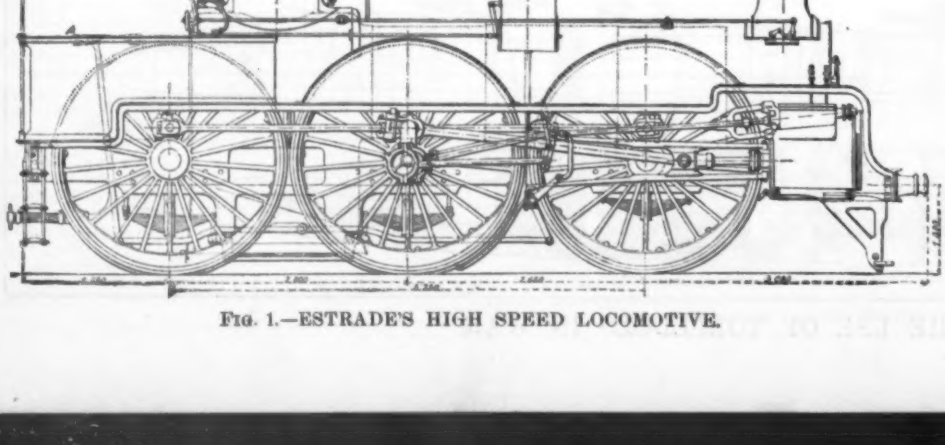
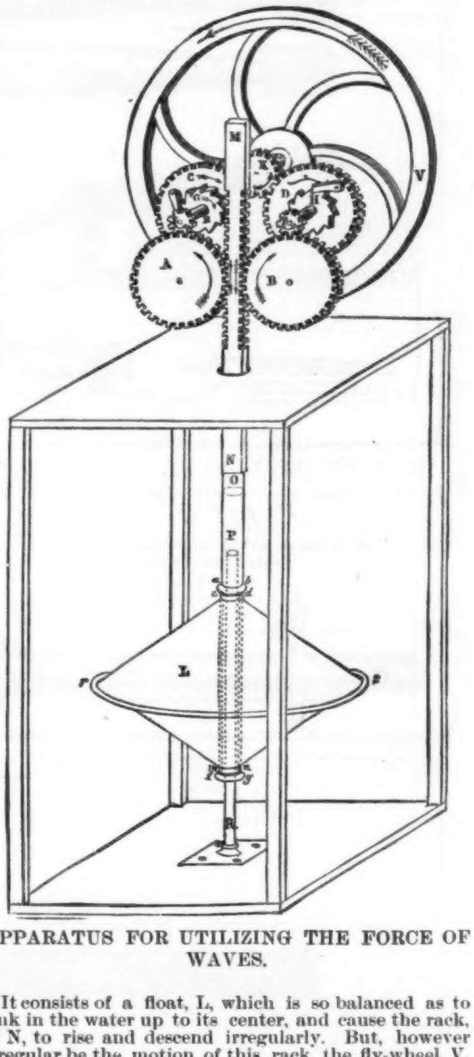


Fig. 1.—ESTRADE'S HIGH SPEED LOCOMOTIVE.

APPARATUS FOR UTILIZING THE FORCE OF WAVES.

The accompanying figure, from *Cosmos*, represents an apparatus proposed by Mr. M. Le Dantec for utilizing the force of waves, especially for the electric lighting of lighthouses.



APPARATUS FOR UTILIZING THE FORCE OF WAVES.

It consists of a float, L, which is so balanced as to sink in the water up to its center, and cause the rack, M N, to rise and descend irregularly. But, however irregular be the motion of this rack, the fly-wheel, V, always revolves in the same direction. When the rack rises, it actuates the wheel, C, through the ratchet, G, which is connected with the pinion, E, through a tubular axle, R, upon which both are fixed. During this time, the ratchet, H, leaves the wheel, D, free.

When the rack descends, it actuates the wheel, D, through the ratchet, H, which connects with the pinion, F, through the tube, T. During this time the ratchet leaves the wheel, C, free.

The pinion, K, and its fly-wheel, V, are therefore always driven in the direction shown by the arrow.

The cone is mounted upon a central tube, *c d m n*, that allows it to revolve horizontally upon the rod of the rack between the two collars, *ab* and *fg*. Owing to this, if the horizontal shock of a wave acts more upon one side than upon the other, the rack will not be submitted to torsion.

The rack rod is a tube that slides upon the central axle, R P, which serves as a guide to it.

The center of the double cone is provided with a thin flange designed for cutting and destroying the horizontal shock of a wave.

Among other purposes for which this simple device is applicable is that of the conversion of irregular motions into a continuous rotary one.

To ventilate a room, and at the same time avoid a draught, raise the lower sash, and shut it down upon a folded blanket placed beneath it, leaving an aperture of several inches between lower edge of upper and upper edge of lower sash.

SIBLEY COLLEGE LECTURES.—V.

BY THE CORNELL UNIVERSITY NON-RESIDENT LECTURERS IN MECHANICAL ENGINEERING.

THE RIDDLE OF THE SPHINX.*

By J. C. BAYLES.

THE fact that "through all the ages one increasing purpose runs" is shown by the remarkable adaptation of classic myths to the uses of modern illustration. The extravagant allegory of the Theban sphinx might almost take rank as an apocalyptic vision, and would not seem out of place in the awful panorama of the future which unrolled before St. John at Patmos. Juno, it will be remembered, sent a formidable creature of composite architecture, to occupy the public highway near Thebes, propound a conundrum to passers-by, and rend and devour those who could not guess it. The thoughtful student of sociology and political economy is conscious of the presence in the great highway of progress of a monster fairly comparable to the sphinx. Its head and breast are human; the expression of its face is calm, but intense, patient, but terrible. Its body is the body of a lion—lithe, pliant, sinewy, and roped with quivering muscles. Its tail is the tail of a serpent. Its folded wings suggest that barriers and obstacles place no restraints upon its movements. Its name is labor; its riddle "the labor question." It stands face to face with society, demanding an answer. It has waited for generations, and perhaps it will wait yet a little longer the tardy response to its grim interrogatory, but it will not wait forever. Complex and difficult as the scarcely understood question it asks admittedly is, the answer must be found, and the flashing eye and lashing tail of the monster warn us that its demand is exigent.

The figure may seem a bold one, but it does not exaggerate the idea it is intended to convey. Unfortunately for society, the monster has a grievance. However blind one may be to the spread and influence of socialistic teachings, there is little excuse for persistence in cherishing the idea that the wage-earner has no cause for dissatisfaction with his situation and prospects, or that his proper duty in life is to imitate the excellent example of the pious shepherd of Salisbury Plain, who derived supreme contentment from the fact that a kind Providence had vouchsafed him salt to eat with his potatoes. Since the French revolution of 1793, there has been a steady, and of late a rapid, progress of the socialistic movement. More general education, a free press, and organization for resistance or aggression have been the agencies by which the working classes have gained clearer ideas of their power and opportunities. The dull despair of mediæval servitude has given place to an intelligent and profound discontent with a situation which every year seems to make more hopeless. Blind Samson stands chained, but if he shall bend himself upon the pillars against which he leans in sullen silence, the whole superstructure of society will come crashing to the ground, and nothing will restrain his purpose, should the mood seize him, even though that which he destroys must inevitably fall upon and crush him.

It is fortunate for those who have what they are pleased to consider, and society to recognize, as "vested rights," that labor has not yet found an answer to its own question. Socialism, using the term comprehensively, has thus far represented many and widely different purposes, immediate and ultimate, often at variance one with another. When its forces shall focalize upon one idea, we may be certain that, right or wrong, that idea will, for the time being, dominate human thought and action. When it shall direct its energies to the attainment of a fixed purpose, practicable or impracticable, it will move with resistless power.

The literature of socialism is a most instructive study, and shows very clearly a slow but steady progress toward the evolution of a social system having for its object the emancipation of labor from a condition of servitude, and the attainment of an equable participation in the products of industry. It is in every aspect a labor movement, and the social revolution it proposes is only an incident of the industrial revolution it seeks to bring about. Such political significance as it possesses is due solely to the fact that under existing systems of government, class distinctions are recognized and guarded, and vested rights respected, including land titles, charters conferring valuable privileges, inheritance and individual proprietorship in many things which labor insists should belong to the State, that is, to the people.

To understand this subject at all, it will not serve our purpose to examine merely such phases as are presented for the study of those who are noting the progress of current events in this country. We must first gain some idea of the tendencies of the labor movement in Europe during at least a century, a retrospect which is necessary for two reasons, first, to show what may have been the aims and objects of social revolution in the past, and, secondly, how much more practical and purposeful the movement is now than it was even a few years ago.

Babœuf, guillotined in May, 1797, for an unsuccessful attempt to overthrow the Directory, was among the earliest of the writers on social problems to give direction to the movement as we find it to-day. Those who preceded him in French economic literature had rather voiced the complaint of the people than sought a means of bettering their condition. This statement should, of course, be made with some qualifications, but it is sufficiently accurate for the purposes of this discussion. Babœuf's leading idea was that "the aim of society is the happiness of all, and happiness consists in equality." Obviously, this is fallacious and self-contradictory. "Let all the arts perish," he proclaimed, "provided we attain real equality." "Nature has given to every man an equal right in the enjoyment of all goods." It is but fair to say that the term "equality" as employed by Babœuf is a mere shibboleth. His dream was a commonwealth in which all titles should be vested in the municipality, the village, the commune, great or small. Production should be carried on in common, and officers selected in some way should equably distribute the fruits of production. He proposed to bring these changes about gradually, titles held by individuals or corporations reverting to the public during, say, fifty years, by the abolition of inheritance. His scheme provided for a government more absolute than any ever known, and a strict censorship of the press was deemed necessary to prevent the spread of erroneous ideas. In a word, it sought equality through the creation of officers with an authority undreamed of under any practicable system, and liberty by means of a government with powers of unlimited oppression. It is safe to say that when Babœuf's head dropped into the basket of sawdust, the cause of humanity did not suffer irreparable loss, whatever his own claims to grateful remembrance.

Cabet, who succeeded Babœuf as an apostle of socialism, gave a new and much more practical direction to the thoughts of those who were seeking to promote a more uniform and evenly developed civilization. Cabet's commune was a very different sort of Utopia from Babœuf's. In a fanciful romance entitled "A Voyage to Icaria," he describes the ideal state of society which he subsequently attempted to realize by founding a colony in what is now a part of Texas. His advance guard of Icarians settled on the Red River, but most of them died of yellow fever before Cabet arrived with a second company of emigrants. Gathering such following as he could command, he abandoned his first location and set out for the deserted city of Nauvoo, the first Mormon capital, intending to occupy it. His company at one time numbered 1,500, but lacking practical aims and without a competent head, they soon scattered. It is an interesting fact that a remnant of the original colony remain and keep the name Icaria, but Cabet's dream has found very limited fulfillment, although the Icarians are still governed according to his teachings. Cabet taught the amiable doctrine of fraternity, but did not demand equality in any literal sense, nor did he seek to abolish the family relation. He was a noble character and a moral hero, and his work has not been without benefit.

The next great light of socialism in France was Saint Simon, who has a good title to grateful remembrance from having aided with his sword the cause of the colonies during the Revolution, and also to a place in American history as the original projector of a transisthmian ship canal to connect the Atlantic and Pacific. In the field of socialism he was an energetic and enthusiastic "crank," deriving his inspiration from Charlemagne, his alleged ancestor, who appeared to him in a vision during his imprisonment at Luxemburg. He suffered all sorts of vicissitudes, battling with proverty and even hunger, to reform society. An unsuccessful attempt at suicide when he was more than sixty years old shows that he considered life a failure, but, recovering, he resumed his labors and printed his three great works, "Catechisme des Industriels," "Noveau Christianisme," and "Systeme Industrielle." He sought the welfare of society by universal peace; employment for all guaranteed by the state; government by a chosen ruler or leader, to be known as First Industrial; the abolition of inheritence and the promotion of the good, the true, and the beautiful. Upon this unobjectionable though impracticable foundation, his followers have built up all sorts of extravagances, for which the impartial biographer will not hold him responsible. He enjoys the distinction of being the first exponent of pure socialism founded on an economic system involving a common production and an equable distribution, but without enforced social equality. After the death of Saint Simon, Enfantin and Bazard became the leaders of the movement, which gained considerable impetus after the revolution of 1830. A division occurred in 1831, and, later, the organization founded by Saint Simon went to pieces, but left its mark indelibly upon the socialistic movement in Europe.

About this time Fourier came to the front, and had some success, even finding followers in this country. I remember very well as a lad visiting a community or phalanx of Fourierites in New Jersey, an experiment in which Horace Greeley, Charles A. Dana, George Ripley, Albert Brisbane, Margaret Fuller, George William Curtis, Nathaniel Hawthorne, Dr. Channing, and many other excellent and eminent people took a great interest. Fourier's ideas were many and somewhat crude. His plan was the establishment of rural agricultural and industrial communities called phalanxes. He had great confidence in hens, and one may find much amusement in reading his calculation of how soon the debt of Great Britain might be paid in eggs. He was, perhaps, the first to devise a system of co-operative production, and one of the indirect results of his labors is the great community in Guise, France, where his best ideas have been realized. M. Goudin, of Guise, is undoubtedly an enlightened and advanced Fourierite, and his work entitled "Solutions Sociales" will probably have a lasting influence. A few facts concerning the great co-operative enterprise of Guise will be given under another head.

During the Empire, Louis Blanc attracted considerable attention in France with schemes of industrial organization, which were tested by the ministry in a way to discredit him and invite failure. The object of these experiments was undoubtedly to destroy the influence of Louis Blanc with the working classes, and convince them that he was a mere empiric, whose leadership they could not safely follow. It is difficult to predict what he might have accomplished with honest co-operation; perhaps as much for France as the eminently practical Rumford accomplished for Bavaria—results, by the way, which show that schemes for the betterment of humanity, the suppression of pauperism and vice and the improvement of the condition of the working classes, are not necessarily impracticable when wisely planned and carried out by the strong arm of autocratic power. I shall probably have something to say concerning Rumford's work in the second division of my subject. Louis Blanc was by no means as great a man as Rumford, but none the less he was one who properly merits the title of great, although, from causes beyond his control, he accomplished comparatively little.

Among recent leaders of the socialistic movement in France, there are many who claim more or less recognition. Proudhon is the most conspicuous, and he was at least successful as an agitator. He was a Radical of the Radicals, an avowed anarchist, and a believer in absolute equality. From such teachings no good can come, and none has come. More recent French writers have advocated the participation of labor in the profits of industry on the basis of industrial partnership, and thousands of French workingmen are conducting small manufacturing enterprises of their own. It is interesting to note in passing that in the city of New York French mechanics are building up an industrial system very different from anything previously known in this country. There are many hundreds of French artisans quietly working in little shops of their own, using small steam powers and light machinery for the manufacture of specialties, in the production of which the great manufacturing establishments have not thus far been able to compete. These men live and work under one roof, and have their shops in all sorts of unexpected places. They manufacture art works of various kinds by electro-metallurgical processes, small art objects for ornamental purposes, passe-partouts and other light picture frames, and fine confectionery. Some of the artisans, working as I have described, are producing very beautiful goods. I know one taciturn old Frenchman, with a shop in the cellar of the house which he divides with three or four other families, who is making armor of the most beautiful design and finish, most of which is sold through the bric-a-brac shops at prices proportionate to the interest of the fictitious narratives furnished with them. These men earn more money and live better than they possibly could as wage earners in the great manufacturing establishments of the city, and if it were not that they are content, as the rule, with very small things, some of the industries they have founded would certainly develop and attain large proportions.

In Germany the socialistic movement has assumed a different and much more interesting phase. With a more intelligent leadership it has sought to build up a school of political economy which shall meet all the requirements of humanity and correct all the evils resulting from or incident to existing conditions. The great socialists of Germany have been students and thinkers rather than dreamers. They have sought to build up, rather than to destroy; to evolve a higher and more regularly developed civilization by practicable measures of reform rather than to attain Utopia by revolution. Although the more advanced have, at times, been held in suppression by the government under severe and, at times, cruel repressive measures, they have at other times exercised an immense influence, and at present the great Bismarck is stealing their ideas and even their shibboleths and incorporating them into the policy of the German Empire.

The representative socialists of Germany have included some of the most remarkable men of the century. If time permitted, we should find it a pleasure and a profit to review their writings. In some respects Karl Rodbertus, who died in 1875, was the most profound student of sociology the world has yet produced. He was to socialism what Ricardo was to political economy—exact, scientific, statistical, incontrovertible. The great evils which he labored to correct are pauperism and commercial crises. These, he believed, could be averted only by a system which guarantees to laborers an equable share in the national production. Such a system must be established, regulated, and maintained by the state, which must fix values and determine the share which labor shall have of that which labor and capital jointly produce. The wages of labor are to be paid in labor-time money, based on the unit of one hour. If the productivity of labor doubles, the unit remains unchanged, and a given amount of labor-time money is doubled in purchasing power. Rodbertus did not believe in the abolition of land titles, nor did he believe that property was robbery. He taught no false doctrine of equality, but demanded that social inequalities should be based on merit alone. He was rather a great teacher than a leader or organizer, and he has left the impress of his thought upon all German socialistic literature of later date.

Another eminent and strictly representative student of social problems was Karl Marx, who died in 1883. Marx was an intellectual giant and a natural leader, but somewhat intemperate in his ideas and methods, and a little too intense for Germany. His most important work, "Capital," was published in London in 1867, and is, in some sense, a sequel to his "Critique on Political Economy," published in 1859. "Capital" has been called the scripture of the social democrats. It is a work of admitted ability and ranks among the greatest treatises on political economy ever written. As an analyst of history Marx was certainly extremely clever, and upon such analysis he built his scheme of social progress and development. He was chiefly instrumental in organizing the International Workingmen's Association, which had vast potentialities of good or evil, but ceased in 1875 to have a visible organized existence. Its spirit still lives, however, and is a potentiality of incalculable power. Its work is not yet accomplished, and cannot be predicted.

Resembling Marx in many respects, but widely differing from him in others, Ferdinand Lasalle is undoubtedly the most brilliant and picturesque figure in the history of social democracy. While yet a student he wrote his "Philosophy of Heraclitus the Obscure," and challenged the attention of the greatest men of his time. Humboldt called him an infant miracle, and sought his friendship. In 1861 he produced his "System of Acquired Rights," which is rated as the ablest legal book of the century. He began his agitation on behalf of the working classes in 1862, with fiery zeal and enthusiasm, tempered by rare tact and discretion. He was the first to effectively organize labor in Germany on a large scale, and its present power in German politics is in a great degree due to his mastership. His writings on social and economic subjects have changed but little, if any, the theory of social democracy. He popularized the profound teachings of Louis Blanc, Rodbertus, and Marx, by presenting them in a form intelligible to the average laborer, and thus vitalized them. His work, however, is not without originality, since he was quick to perceive and apply the economic laws which others had patiently formulated and statistically demonstrated. Perhaps, however, he will be misjudged if judged by his socialistic writings alone. It is safe to assume that he adapted his teachings to those he taught, and advanced only such propositions for immediate consideration as he thought would be understood and accepted by his followers, intending to lead them on step by step as they progressed in intelligence and gained capacity for organization and concerted action. His death in a duel terminated his brilliant, but somewhat unfruitful, career. Had he lived ten years longer, the Universal German Laborers' Union, which he founded, would probably have become a mighty power, but it has since lacked a leader of Lasalle's capacity. Prince Bismarck knew and greatly

* Portions of this lecture are adapted from an address on "The Engineer and the Wage Earner," delivered by the author as President of the American Institute of Mining Engineers, at the meeting in Halifax, N. S., September, 1885.

admired Lasalle, and has been, it is said, in no small degree influenced by his writing. The accident insurance law of Germany was a distinctive socialistic measure, and others of like nature are expected to follow. It is an interesting fact that the Chancellor of the German Empire, who once persecuted the social democrats as Saul persecuted the early Christians, has acknowledged their power and is yielding to it, though without confessing it.

At the present time the professorial school of socialists is doing most to promote the progress of socialism in Germany. Its representatives include many of the best men at the German universities, and their influence upon the rising generation is obviously very great. In Great Britain socialism is apparently something quite different from what we find it on the Continent. Under judicious and enlightened leadership it has accomplished great things in co-operative distribution, and aims at results equally important in co-operative production. It is moving slowly and by practical means to the attainment of desirable ends, and among these is the solution of the land question and the curtailment of the power of the Peers. Mr. James Swift, General Secretary of the Steam Engine Makers' Society, in a report on the progress of the labor movement from 1866 to 1886, concludes as follows: "Trades unions and their members were ridiculed, condemned, and despised in 1866. . . . All this has been changed within the twenty years that have intervened, which goes to prove that extensive reforms have been effected in combinations, to secure the influence they possess and the power they are at the present day. Their members are no longer (in a moral sense) outlaws; they are no longer under fear of prosecutions for asserting the terms on which they will dispose of their labor. Their societies' funds are protected, and their leaders secure the respect of former opponents. Their societies are strong, but they rarely abuse their strength, and as a rule their members are law-abiding citizens. They have a great future before them if they use their power wisely, while their political influence can decide the fate of governments. They have also serious responsibilities to their fellow workmen and the country generally; but we have every confidence that the future will see them discharge their duty to their employers, their duty to the state, and help to maintain our country's supremacy as the chief manufacturers of the world."

In Russia socialism is so closely identified with nihilism that it is difficult to separate them. Its best known leaders are mostly in Siberia, and until political revolution shall have emancipated the people, freedom of speech and organization for the promotion of social progress will be impossible. In southern Europe the Black Hand represents the most advanced ideas of agitators and revolutionists, and concerning this we can know but little. I think the time not far distant, however, when we shall learn more.

From such study of socialism in Europe as I have been able to make, I am convinced its tendency is in the direction of revolution—primarily political, secondarily economic. Its political significance is at the moment paramount. This is natural, for the reason that until the whole system of government is changed in every European country, no scheme of social progress is considered practicable. Of necessity the socialist becomes a revolutionist, and it is not surprising that all forms of nihilism, communism, and political conspiracy derive their support from the classes which feel that the burden of misgovernment must be lifted from their shoulders before they can stand erect and claim their rights as citizens and producers. The labor question there is, consequently, a very different one from that which presents itself here. An intelligent and progressive nation, living under a government "of the people, by the people, and for the people," with every natural and acquired advantage, should be and probably will be the ones to lead the movement by which the great social problem is to be solved. For this reason it has for us an interest quite distinct from that which attaches to its phases in the Old World.

Those of us who trace our origin to New England stock, and who claim a more or less direct inheritance of name and character from the Pilgrim fathers, should remember that Plymouth was a socialistic experiment. The Pilgrims were largely agricultural laborers, who had a double reason for leaving England. Religious persecution was one reason; a desire to exempt themselves from conditions hopelessly opposed to the improvement of their fortunes was another. We may also remember without injustice to their memory that they endured the privations and sufferings here encountered, not wholly because of a force of character which forbade them to abandon an enterprise in which they had engaged, but because the conditions to which they must return, if they abandoned the shores of America, were even less agreeable than those they must face by remaining. They founded here a commonwealth, with equality and fraternity as its corner stone. It was not long before they found that severalty in ownership was essential to social welfare, and the New England of to-day may be considered the legitimate outgrowth of this discovery.

So far as I can learn, those who are likely to exercise an important influence upon the working classes of this country have very different aims in view from those presented in the writings of representative European socialists. It involves a great mistake, however, to define socialism as a noxious exotic brought here by immigrants who were born discontented. The cause of humanity is universal, but different evils demand different remedies. Perhaps we can readily understand how it is that centuries of misgovernment and oppression, and the accumulated burdens of extravagant monarchies and useless wars, have made the working classes of Europe restless and discontented; but why, it is asked, should unrest and discontent exist in this great and new world? Here no man is oppressed; equal citizenship and a free ballot place each man's destiny in his own hands.

I grant that the conditions here are different from those existing in most countries of the Old World, and that the difference is in favor of the working classes of America; but even a casual examination of the relations which have already taken shape between the social classes here will show that we have grave problems of our own to consider, which demand our most careful study. Of these the least serious are those which attract the attention of the newspapers and invite the interference of the police. The inflammatory utterances of nihilist refugees and the vehement orators of the Sand Lots, the resolutions passed at meetings of the so-called communists and the impotent conspiracies of restless spirits who delight in planning revolution and destruction, may be dismissed as mere breaches of the peace. This is the serpent tail of the Sphinx, disquieting but comparatively harmless—the rattle, not the fang. The movement which has in it the power and potency of unmeasured good or evil makes no threats, hides no incendiary torch, and plots no secret deeds of violence. It does not rendezvous in beer cellars and gather in mobs to terrorize our city authorities. It has organization, however, and is felt in the councils of the working classes. Even in free America socialism has gained more than a foothold, and its influence is already seen and felt in legislation directed against monopolies. The Granger movement in the Western States, the advocacy of the postal telegraph, the opposition to national banks, the outcry against land grants and subsidies, trade unions, national labor leagues, anti-monopoly leagues, co-operative insurance associations—these are a few of the phases of socialism in its American aspect. All such movements are tending in one direction, and are prompted by the instinct of self-protection.

In reasoning upon this subject, especially if misled by the illusions of half-knowledge, it is easy to deceive one's self. There was a time when industry and thrift were the sole conditions of success in this country. Perhaps they still are in portions of our territory newly opened to settlement, and, to a certain limited extent, in the older and more thickly settled districts. But one who ventures to talk that sort of platitudes to the wage-earner in any of our great productive industries will be likely to fatigue him. It is undoubtedly true that in no country of the world has the man with labor to sell so free a market in which to sell it as in America. The country is yet comparatively new, and there is still so much land open to settlement that mouths have not yet begun to multiply more rapidly than food. There are so many examples in which, under favoring conditions, industry and thrift have secured to the wage-earner independence, and even wealth, that those of us who have never known from personal experience what it is to overcome the difficulties which beset the mechanic in his struggle for self-improvement and social advancement are very free with good advice for those who ask it, as well as for those who do not. But there is good reason to suppose that we know very little of the actual situation of the average workingman, and that we have no adequate conception of the strength of the cords which bind him down in the place which our industrial system has made for him. In considering the position of the wage earner in any one of our great industries, we must remember that the progress of half a century has closed to him many of the doors which once stood open to industry and thrift. The high perfection of the machinery employed in all branches of production has destroyed the apprentice system, or at least so much of it as was advantageous to the apprentice.

The young man upon whom devolves the necessity of self-support has very little chance to learn a trade. He can and does learn a part of it, but beyond acquiring a general familiarity with one or two operations in an industrial process, he reaches man's estate with very little more knowledge of the trade he has undertaken to master than he had when he began. His chances of gaining the comprehensive knowledge which is needed to fit him for advancement to responsible positions of management and direction are so small that they may be said to be as nothing. His early education is such as boys without home advantages are likely to gain in the free schools, and of this he will retain only the elements. He can read, write, and compute in the four simple rules of arithmetic; but his mind is untrained, and unless he has a strong natural bent for study there is little likelihood of his supplementing the deficiencies of his education by systematic and profitable reading. Were he disposed to do this, he could not find the books which would serve his purpose. Even elementary works presume a knowledge greater than his, and if he should make the attempt, as thousands of ambitious young mechanics have done, to improve his mind by reading the text-books of his trade, he would abandon the task, as thousands have before him, because between him and the beginnings of technical literature there is a gulf which he finds impassable. He knows his daily work, and it yields him a support. The future is before him—full of hope, perhaps, but offering no tangible goal for his ambition. As the rule, he marries young. His earnings will support a wife, living as the people of his class live, and he cuts off the slight remaining chance of bettering his condition by thus anchoring himself in the sphere to which he was born. The children which come to him are dear to his heart, but every one added to the number is only another millstone about the neck of his ambition. His home may be as happy and comfortable as a virtuous and industrious wife can make it with the slender resources at her command, but it is cramped and crowded, and the ever-present cradle is an obstacle to self-improvement which only genius can overcome. His youthful ambition matures into the hope that he will be able to earn food and shelter for his dependents. He realizes, however, that he is but a part of the great industrial machine, and that forces as far beyond his individual control as are those which hold the planets in their orbits determine whether he shall attain the measure of even this reasonable hope. He works when it serves the purpose of capital that he shall work; he stands idle when capital orders production to stop. His savings in time of prosperity are consumed in times of depression, and the debts then incurred become a mortgage upon his future. His children have no brighter outlook than he had. As they grow up, each in turn must help carry the burden. Of what use is it to him to know that in the far West there are unmeasured acres of fertile land, and that he may have a farm for the asking? How shall he get there? How can he bridge the interval between leaving the daily work which feeds his family and reaping the harvest which that land would yield? How shall he build his house and his barn and provide the implements of husbandry? Who will teach him how to break the virgin soil and plant the fruitful seed? He cannot escape from the servitude of his trade, whatever its vicissitudes. He is a free citizen of a free country, but the brass collar of Gurth, born thrall of Cedric the Saxon, was lighter and more easily borne than are the shackles with which the exigent demands of his daily life have bound him hand and foot.

The wage-earner may be ignorant of science and the arts, and the sum of his exact knowledge may be only that which he has gained in his closely circumscribed daily toil; but he is not blind, and his thoughts do not take the shape of daily and hourly thanksgiving that his condition is not worse than it is. He sees on every side the lavish display of wealth in which he has no part. He sees a large and growing class enjoying inherited abundance. In a word, he sees the power of capital ever widening while the sphere of the wage-earner is becoming daily more and more circumscribed. He cannot fail to reason that there must be something wrong in a system which effects such unequal distribution of the wealth created by labor. In the union, which is his defense against the oppressions of individual or corporate greed, he meets the thousand others who, like himself, feel that their only hope is in destroying the existing relations of labor and capital and substituting for them a better and more equable system of joint participation in the profits of production. He may reason wrongly, but it does not help the matter to tell him so. He may act on wrong impulses, but if repressed and defeated, he will try again. With him the impulse to pull down and destroy, and to create equality in suffering because no other equality is possible, does not now exist as a purpose; but scarcely a year passes without giving evidence that it may flash into instant action, and that in the discontent of the working classes we have the potentialities of inestimable catastrophe.

If the average wage-earner was in any sense to blame for having stood still while more enterprising and more fortunate members of society climbed past him to the higher planes he cannot now reach, he would be entitled to very different sort of consideration. The hopelessness of his position consists in his ignorance. The progress of the arts has been so rapid that few men starting in life without education are able to keep pace with them, or, indeed, to acquire such familiarity with principles that they can hope to attain to responsible positions of management. While the sphere of those born to serve has been thus steadily narrowing, the sphere of those so fortunately situated that they have been able to acquire liberal education is steadily broadening. The capitalist is rarely safe in intrusting his interests in production to the merely practical man. Success in business enterprises of every kind now depends upon so many things of which the merely practical man knows little or nothing, that management is usually intrusted to the man who combines education and experience, and his staff of responsible assistants is made up of young men of education, who take subordinate positions to gain experience. In all but exceptional instances, the future of the average mechanic promises nothing better than continuance in the labor he has learned, as a competitor with machinery which may at any time displace him, and force him to seek some other and perhaps less congenial employment, or starve.

We must also remember that in an industrial system good organization tends to the specialization of labor. The superintendent of a manufacturing establishment rarely has an application for employment from a mechanic who knows the trade as a trade, and is prepared for any assignment which may be given him. He must organize his working force by selecting from applicants each of whom has, or claims, a special skill in one operation or process; and the greater the industry, the more marked the subdivision of labor. Even in shoe making there are many processes, and the man who has learned to polish heels would have a new trade to learn if set to pegging soles or cramping uppers. This specialization of labor is the direct result of the introduction of machinery in mechanical processes; and while it is undoubtedly true that man plus machinery is the industrial unit, man has become a factor of uncertain and steadily diminishing value. The workingman realizes this more and more keenly every year. He sees that an industrial system which considers only the volume and economy of production has cut him off from the chance of learning the trade at which he works; and the schools from which he and his children can derive no benefit are furnishing graduates whose superior fitness for organization and management close to him every avenue of advancement. To dispense with the little skill he has gained is the constant aim of his superiors, and he can never know when arms of iron that tire not, and fingers of steel that work with mechanical precision, shall come to take his place, or when the progress of science shall discover ways of rendering his knowledge of no further use. Is it to be wondered at that such a man is discontented and restless, and that if it is left to him to solve the great problem of a satisfactory readjustment of the relations of the classes, he will try dangerous and impractical methods, knowing no others? He has a grievance in the misfortune of birth under conditions which have given him little or no chance for self-improvement, and he rebels against his fate. These are plain and practical truths, known to us all, but perhaps not realized in all their grim significance. We no longer have use as an industrial symbol for the brawny arm wielding a hammer with which we were once familiar, and may forget the old couplet,

> "By hammer and hand
> All arts do stand."

It is the shape of a man's head, and not the circumference of his arm, which determines his place in the industries, and our new couplet might read,

> "Brains command
> Both hammer and hand."

To show how much of warrant there is for the feeling on the part of labor that even in America its position is one of helpless and hopeless servitude, one need but quote the arrogant language of those who represent the employing class. Some months ago there was a strike in an important Western iron works against an oppressive reduction of wages. During the course of this strike one of the owners of the mill was interviewed as to its probable outcome, and expressed himself in a way calculated to bring the hot blush of shame to the cheek of every man with self-respect or respect for his fellow men. Omitting names, I quote him as follows:

"The iron and steel business is depressed, and what do we care whether the mills are running or not? I am only a small stockholder, but what does Mr. A, Mr. B, or Mr. C care about the strike? All the directors of

the company are off enjoying their vacations, and they will eat just as many square meals and drink as many kinds of wine for dinner as though the mills were in full blast. Why should they care? They are all independent of the income they may derive from the Cleveland Rolling Mill Company. Mr. C, I know, has an income of $30,000 a year from another source. *I tell you, the directors will see the grass growing ten feet high all over the mill before they will yield to the strikers.* And while the directors are enjoying themselves, *these cattle out here are starving.* We call them cattle because we hire them, not for the brains but for the muscle that is in them. They are not to blame because they are cattle. It is their misfortune. I like to see the laborers get all they can, and I am sorry for these poor devils, but, pshaw! they can never force their terms. They must come to us. *Yes, it is true that our company has made thousands, and I might say millions, 'but are we going to distribute the profits now with these workmen?* Not much. *I tell you, we've raised the Black Flag, and we are going to keep it up.* The strikers can hold their meetings and resolve and write lies to the papers, and the papers can damn the . . . rolling mill company, and it won't amount to the snap of a finger. . . . We . . . have canceled our orders, and can well afford to rest. Pretty soon these poor devils will come begging to get back, and we will take back all we see fit to at our terms. We beat them years ago, and we will always beat them."

Commenting on this arrogant and even brutal boast, a labor paper said:

"These utterances remind us of similar expressions used just before the French revolution. . . . The picture is just the same. The nobles (or stockholders) have made thousands, and even millions, off the labor of their 'cattle,' as this fool . . . dares to call them; yet they are unwilling to abate one jot or tittle of their 'rights.' They must eat as many delicacies and drink as many different kinds of wine as before. . . . With an honest stupidity he goes on to tell why 'we' call the workingmen 'cattle,' goes on to acknowledge that they have made thousands and even millions of dollars in the past, yet for all that the wages of their 'cattle' must come down as they wish. So far the French revolution has repeated itself with strange fidelity. The same bread riots, labor disturbances on the part of 'cattle, as we call them,' the same disregard of modest demands, the same haughty, aristocratic spirit opposing every compromise, granting nothing to avert starvation, as previous to 1789. That French fool of a wit who said the 'canaille could eat grass' received a terrible punishment a few years later. He was caught by a 'mob,' and hung to a lamp post. His mouth was stuffed with grass. His head was severed from the body, and, elevated on a pike, it was carried through the aristocratic quarters. The flippant mouth stuffed with the grass it had advised the people to eat might have been a warning for all ages to come, if fools could be warned. We should not be surprised if the similarity to the French revolution repeated itself still further. 'Cattle' will play an important and vigorous part then."

I present these quotations as striking illustrations of cause and effect. One has better reason to wonder at the cruel boastfulness of the employer than at the impassioned and indignant response of the workingman. The incident is characteristic. It illustrates the relation which unquestionably exists between capital and labor in a general way; it shows how capital seeks to guard its interests, and what schemes of retribution are taking shape in the brain of labor. If, through ignorance and moral helplessness, the wage earning classes are to the classes who govern through superior intelligence as cattle to their masters, it need cause no surprise if they exercise their brute force ruthlessly and with no conception of the ultimate consequences.

Henry George, in his "Progress and Poverty," states certain startling facts with great force. Perhaps, however, the coincidence to which he calls attention cannot be more strikingly illustrated than by means of a parable based upon the happenings of a few years in a town which, within my recollection, has grown from a village to a manufacturing center. Why progress is, as Henry George describes it, a wedge driven not under but through society, raising those above the point of separation and degrading those below it, I leave to the political economists to explain. How it operates in the way described I shall try to show by a simple and easily understood illustration.

In 1860 the village, which we will call Linden, had the characteristic features of all villages in agricultural districts, and the traveler alighting from the stage coach at the steps of its little tavern felt that, at last, he had placed himself outside the busy circle of the world's activities and industries. Linden was not a paradise, and no doubt the younger portion of the community thought it a very dull, sleepy place, without enterprise—a good place to get away from as soon as possible. But to the student of social problems Linden was a most interesting village. It contained but little wealth, but one might look there in vain for evidences of the kind of proverty with which dwellers in more progressive neighborhoods are so familiar. Some had a modest property, and others had little or nothing, but social distinctions based on these differences were unknown. Force of character and moral worth gave some a recognized social and political leadership, but in church or town meeting or neighborly intercourse, the richest and the poorest met on equal terms, and the son of the "Squire," who had been in the legislature and occupied the most pretentious mansion on the main street, might woo and wed the daughter of the poor widow who nursed the sick and wove carpet rags for support, if thither attracted by a fair face and a good name, without the sacrifice of any social advantage. There was enough for all, room for all, work for all. Even the village drunkard somehow managed to eke out a precarious but sufficient subsistence, and his sons and daughters found shelter in other and better homes, and, being themselves worthy and reputable, were welcome to a place in its social life.

If the traveler was interested in problems akin to those which engage our attention to-night, he would look about him to see how labor fared in this community. Among the resident mechanics were those usually found in villages which are the centers of small and scattered agricultural communities. Probably the most important of the village artisans was the blacksmith. He was a man wise in his craft, an ingenious practical mechanic who could meet all the demands upon his skill. He was not always busy at the anvil, and his charges were certainly not exorbitant, but he owned and occupied as comfortable a home as any in the village, and was a much respected man. People called him "fore-handed." He was a deacon in the church, a selectman, and as a citizen he had no reason to take off his hat to any one. The harness maker was also the person of considerable local importance. His shop adjoined his comfortable dwelling, and his daughter taught the village school. For years he had been a justice of the peace, and was regarded as a valuable citizen and an excellent neighbor. In the hollow near the brook was the shop of the wheelwright and the wagon maker. He lived in a comfortable house with a few acres of well cultivated land about it, and between his trade and incidental farming had done well and accumulated something. There was also the carpenter. He was "a handy man," as the neighbors said, and could do anything from building a house or barn to mending a broken cradle. He worked at his trade when opportunity offered, and on his land between times, and in one way or another had managed to live comfortably and maintain a good social position. The village also had its tinsmith and general mechanic, who sold stoves and in the mechanical line did almost everything which the blacksmith or carpenter could not do. He owned a comfortable house, and his family was as good as any one's family. The student of the labor problem noting these facts would naturally conclude that here the problem had solved itself. Linden was the Utopia of the socialist's dream. Here labor paid no tribute to capital, but enjoyed the fruits of industry, and poverty was unknown. Such was the fact, and thus it might have been to-day had not the wave of progress which swept over the country between 1860 and 1870 struck this happy village, and inspired its people with a desire to stimulate its growth and make it more important than a dot on the county map. In 1861 it secured a railroad connection with the nearest large town, and the completion of the line was the occasion of a great local celebration. But if the happenings of the future could have been foreseen, the shriek of the first locomotive that passed through Linden would have sounded to more than one of the delighted people like the wail of the Banshee, foretelling grief and calamity.

When the new railroad was fairly in operation, the good people of the village began to feel very enterprising. Desirable real estate was held at double its former valuation, and those who owned it congratulated themselves that they had grown quite rich. To bring in fresh population, increase the local business, and make Linden an important town was a perfectly natural ambition on the part of the more public spirited citizens. It was discovered that good natural advantages for manufacturing existed, and if these were made evident, outside capital would come in and "boom" Linden into prominence. One day there was held in the Squire's office a meeting at which probably a dozen leading citizens were present. They included the Squire, three or four farmers who had retired with a modest competence, the two general store-keepers of the village, the blacksmith, the wheelwright, the local physician, and a few others. The object of the meeting was to consider the advisability of organizing a company to manufacture farm wagons and agricultural implements. The wheelwright and blacksmith had conceived the idea, and were prepared to undertake its practical management, besides subscribing something to the capital if the company could be organized. The necessary investments and estimated profits were carefully considered, and the result of the meeting was the organization of the Linden Manufacturing Co., with a capital of $100,000—$50,000 paid in. The people held their breath when the announcement was made public, and visions of a future great city came in dreams that night to more than one of those who had staked all they had or could borrow upon the issue of the enterprise. The Squire was elected president of the company, as the one best fitted to conduct its financial management. The wheelwright, a clever, energetic man, became secretary and treasurer. The blacksmith was elected superintendent, and from the other stockholders a board of directors was chosen. The company was duly incorporated, the capital subscribed, and work upon a factory begun.

In considering the details of the scheme, it became evident that the village did not afford accommodations for the families of the workmen to be employed, and this must be provided for. The company must build some houses. After due conference, a piece of land—cheap, low-lying, and undesirable—was selected, and a dozen or more houses built, the like of which had never before been seen in Linden. Lots thirty feet wide and fifty feet deep were deemed to be large enough, "because, you know," said the president, "these workmen won't have any time to make garden." A rental of fifty dollars a year was all that the company expected, and they built with a view to making that amount of income cover interest and taxes. It never occurred to the wheelwright secretary or the blacksmith superintendent that the company should provide houses like theirs for the workmen who were coming. Cheap tenements in a crowded row were good enough. They knew how wage-earners lived in other centers, large and small, and Linden must provide tenements suitable for poor people if it wanted the advantages of manufacturing. Finally the preparations were completed. The factory was started with labor gathered from anywhere, and everybody shook hands with his neighbor and congratulated him that, with a railroad connection and a factory, Linden was on the high road to prosperity.

Ten years pass. Let us look at Linden again, and see what has befallen the pretty village. It would be hard to recognize it, so completely has it changed. The wagon and implement factory has become a great establishment, widely known for the excellence of its product, and paying its stockholders large dividends. It employs in its several departments at least two hundred men. There are three other manufactories in town, all doing well—from the stockholders' point of view. In fact, it has become quite a manufacturing center, and has a population of something over 3,000, mostly dependent upon local industries. We notice some familiar buildings. There is the Squire's house, now owned and occupied by a local tradesman. The Squire's new house is that pretentious mansion on the hill yonder—the finest in town. The one to the right is the new house of the secretary of the wagon company. The house he used to live in now holds two or three families. That substantial brick house on the corner belongs to the general superintendent of the same company. He used to be the village blacksmith, but is now a bank director and a very important personage. In fact, all the large and pretentious houses in this part of the town belong to gentlemen more or less prominently identified with manufacturing. Now, let us take a look on the other side of the railroad. Here we find something very different. The tenements built by the wagon manufacturing company ten years ago look really aristocratic amid their yet meaner surroundings. Linden has back streets now, and neighborhoods of a kind one might have sought in vain in the village as we remember it. A good many of the mechanic class have died since the factory was started, and left widows and orphans without support. Linden has plenty of poor, and the ladies on the hill find amusement and a certain sentimental exaltation in maintaining a system of charitable relief, which, as usual, reaches the least deserving first and exhausts itself in encouraging mendicancy. The wage earners live very differently from the mechanics of the village as we first knew it. There is not one of them who could own or rent the blacksmith's old home, or that of the harness maker. If he had one of those places rent free, he could not afford to live in it and keep it up in good shape.

If we remain a while in Linden, we shall find that its social life has changed as much as the outward appearance of the village. The Squire's family have become extremely exclusive. They are the center of a little coterie which includes people who have been so fortunate as to make money, but does not include many of their old associates of village days. Many of them spend their winters away from Linden, and during the summer depend for pleasure more upon company from town than upon anything which the village affords.

To the people of this class, the workingmen and their families are known merely as so many common people, made of coarser clay than they and in no way a matter of concern until they invite the attention of the constables or come under the supervision of the ladies' relief association. Indeed, there are few places in which social distinctions are so marked as in Linden. Moral worth counts for very little unless it is gilded. All this has come about within ten years. During this period the rich have become obviously richer and the poor evidently poorer. There are several saloons in the hollow, which seem to be well patronized. "By whom?" you ask. "By the working men principally." "But," you say, "when I was here before, the mechanics I met were not the kind who would have given the saloons much support, even had they been more numerous." "No," replies your guide, "they were a very different sort of people from these." "Did not the difference," you ask, "result in great degree from the restraints imposed by their social position? Was not the fact that they were respected by others and socially recognized the source of that self-respect which made them what they were?" "No doubt," answers your companion, "but all that has changed now. These workmen must be content with their own society. No one else either cares or knows what they do when they are not working." "But do not the good influences of church and school operate as they used to?" "Oh, no," answers your companion. "Why should they? These people have no place even in the churches where the richer people attend. There is a little missionary chapel over yonder, where they can go if they want to, but if they were to show themselves in one of the churches in the upper part of the town, they would be frozen out very quickly. As to the schools, only workingmen's children attend those which are free. People of means send their children to the Academy and pay for their tuition rather than have them contaminated by daily contact with children born under less advantageous circumstances." Having a favorable opportunity to talk with an intelligent workman, you ask him how it fares with him, and he replies, "Oh, well, I don't know as I have any reason to complain. The company pay as good wages as I could get elsewhere, and I manage to get along, although it is pretty close work to keep out of debt and maintain a decent appearance. The company is paying big dividends, I am told, but I don't know as that does us any good."

Let us visit Linden again a few years later. General business is not prosperous just now, and the demand for wagons and agricultural implements has fallen off to such an extent that stock is accumulating in its warehouses. The directors of the Linden Manufacturing Co. have a meeting, and decide upon a 15 per cent. reduction of wages. The men demur. "Very well," says the superintendent, "we will close the works. It is of no advantage for us to go on manufacturing just for your accommodation. During prosperous times we paid you good wages, and now that business is dull and prices low, you decline to accede to a necessary and reasonable reduction. The company has treated you right in every way. We should not reduce your wages if we did not consider it necessary to do so, but since you have refused, I hereby give notice that every man who does not go to work next Monday morning at the prices named may consider himself discharged, and if we have to close the works, we will do so."

This ultimatum is received in silence, and the men withdraw to confer. That evening the room of the local union is crowded, and when the meeting is called to order there is an ominous stillness. The chairman briefly states the object of the meeting. He says: "We are called together to consider what action we shall take on the proposition of the Linden Manufacturing Co. to reduce our wages 15 per cent. It is unnecessary, gentlemen, that I should call your attention to the importance of deciding this question with deliberation. What is your pleasure?"

A man in the middle of the room rises. "Mr. Chairman: I move it is the sense of this meeting that the following resolutions be adopted: *Resolved*, that the employes of the Linden Manufacturing Co. respectfully request the officers to submit to a committee of arbitration the question whether a reduction of wages is called for at this time, and if so, how much. *Resolved*, that we name Richard Henning, Thomas W. Brunson, and Matthew Reardon a committee of three to represent the workingmen, with authority to agree on our behalf to the decision of a board composed of the three men named, three representatives of the company, and one other to be chosen by a majority of the six."

After some debate, the resolution is adopted by a decisive majority. A committee is appointed to wait upon the superintendent and obtain his answer, and the meeting adjourns until 8 o'clock the following evening.

The appointed hour found the room again full of anxious workmen. The chairman took his seat, called the meeting to order, and directed the reading of the minutes. The first business in order was the report of the special committee appointed to confer with the superintendent. The chairman of the committee arose and spoke as follows: "Mr. President: Your committee appointed to wait upon the superintendent and present the resolutions adopted last evening regret the necessity of reporting that their errand was unsuccessful. Mr. Brown at first refused to see us as a committee, sending out word that the company was willing to hear what any workman in their employ might have to say for himself, but that they must decline to receive a delegation as a delegation. With the consent of my associates, I then asked to see Mr. Brown alone, and was admitted to his office. He asked whether I had come to say that I would or would not go to work Monday morning at the reduction. I said to him, 'Mr. Brown, I cannot answer that question just now, but if you will hear what I have to say, I will probably be able to answer you day after to-morrow.' 'Very well,' said he, 'go on.' I then told him that last night the men affected by the proposed reduction had a meeting and adopted a set of resolutions which I had been instructed to present for his consideration. I handed him the paper, and he read it. 'Is that all you have to say to me?' he asked. I said it was all at present. 'Well,' said he 'I will send you an answer in writing to-morrow.' I then came away, and about an hour ago I received this letter, which, with your permission, I will read:

OFFICE OF THE LINDEN MANUFACTURING CO.
June 4, 1877.

Mr. Richard Henning:

The resolutions you handed me yesterday were duly considered at a meeting of the directors held last evening, and I am instructed to reply as follows:

The Linden Manufacturing Co. does not recognize any meeting or committee as authorized to express or convey the decision of those in its employ. However, as it is well to avoid any misunderstandings, you are authorized to communicate to whom you will the contents of this letter.

The officers of this company decline to submit to arbitration any question at present at issue between themselves and those in their employ. They consider themselves perfectly competent to manage their own business, and have no use for the services, in an advisory capacity, of the persons named in the resolution.

As bearing upon your personal decision, permit me to say that the reduction of wages decided upon has become necessary, owing to the depressed condition of trade and the decline in prices. If we consulted our own interests, we should close the works; but rather than do this we are willing to give employment to such of our hands as care to accept a proposition which we deem liberal. Those who do not want to work for the wages offered need not do so. We shall not undertake to coerce or persuade them. When we feel that we can advance wages again, we will do so; but if our workmen decide to strike, we shall simply carry out our original intention of closing the works until such time as it suits us to open them again. We shall submit to no dictation now or in future, and those who do not like our system of management can look for work where they will be better suited.

If you are pleased to make any use of this letter in a public meeting, please say that the company requests that no more committees be appointed to wait upon the superintendent, as he will be under the necessity of declining to recognize them as representing any one but themselves, or, in the event of a strike, as workmen in the company's employ.

Respectfully,
G. R. BROWN, *Superintendent.*

The reading of this letter, though not materially differing from what had been expected, created a profound indignation. It was a cold-blooded, insulting document—a heartless assertion of arbitrary power. The men, who might have conceded a reduction of 15 per cent. had the reasons for it been explained to them, and a promise made them in good faith that their interests would be protected in future, felt justly incensed at the tone of the superintendent's communication, and for two hours the hall rang with vigorous denunciations of the company and its management, and stirring appeals to those present to resist its policy of oppression at any sacrifice. Before the discussion closed an old man arose and secured recognition. He said: "Mr. President: I am old enough to have learned something from experience, and one of the things I have learned is that, however hot the frying pan may be, the fire is hotter. The letter which has been sent in reply to our resolutions is an insult to this meeting. It is a good thing to remember, but it is not well for us to move to our own disadvantage under the impulse of passion. The company has got us where we cannot help ourselves. We had better submit until it comes our turn. My advice is that we go to work on Monday, and if we must accept the 15 per cent. reduction, let it be with the determination that the company must pay it back with interest when the time comes.

"I came here when the business started in 1862. It was a small concern then, and there are not more than two or three in the room who came when I did. This man Brown, who writes so supercilious, was a blacksmith, and was no better than any one else. There was not a stockholder in the company who was any better than I was, and half the capital with which the concern started was borrowed. Look at them now. Every one of them is rich, and people like us aint good enough for them to wipe their feet on. What has made them rich? Was it their capital or was it our labor? For every dollar they have paid us, we have earned them five, and while they have got rich, how is it with us? I am poorer to-day, a great deal, than when I came here fourteen years ago, for I have not the health and strength I had then. It costs more to live, and I have less to live on. I used to live in a house, but I scarcely know what to call the place I live in now. Probably Mr. Brown would call it a sty. Do you think I love these men who have grown rich on my labor? Do you think I would hold my hand if I could make them feel the blow I would strike if I could? When the time comes, I would cut off my right arm if I could pay these men the debt I owe them. Damn their hypocritical professions of poverty and the necessity of cutting down wages. They have $100,000 of surplus, and if the men in this room do not sooner or later divide that surplus, they will deserve to go hungry; but not now. I move that this meeting adjourn subject to the call of the chair."

The speech had its effect. Its hidden meaning was well understood, and when, on the following Monday, every man was at his place, the people who judged from surface indication only might have supposed that the trouble was over. The president shook hands with the superintendent, and the directors congratulated him on the masterly way in which he had managed the workmen and stamped out the spirit of insubordination which had begun to show itself. But there was no handshaking or congratulation in the shop. The men were sullen and silent, working without heart and seizing every opportunity which offered to reduce the value of their labor as much as the company had reduced wages. And when Saturday night came, and each man took his envelope, he squeezed it between his thumb and first finger, and, realizing how little was in it, cursed in his heart the company and all its belongings.

Meanwhile the words of the old man had not been forgotten, and a deep-seated desire to make the company pay dearly for its triumph in 1877 took possession of those who were regarded as leaders. The local unions were strengthened and brought into closer relations with the national unions, and those who were in a position to save something from their scanty earnings became frugal, knowing that they would need a reserve when the time came. The superintendent was aware of the preparations in progress, but paid very little attention to them. What he had done once he could do again; but as a precaution against the trouble he evidently feared, one after another of those known to be most active in union matters were discharged on convenient pretexts, as a wholesome example to the others.

So matters continued until 1879, when the rising tide of prosperity which began in 1878 became a tidal wave of speculative excitement. The Linden Manufacturing Co. began to feel the impetus toward the close of 1878, and by the end of that year were booming ahead in splendid fashion. About that time the men began to be troublesome. The superintendent was notified by a committee that wages must be advanced 15 per cent. After some lofty talk on his part, the demand was acceded to. He was then notified that some of the shop rules must be rescinded. It was not a time for contest with labor. The company must make hay while the sun was shining, so the objectionable rules were rescinded. Then one after another of the trades represented in the shop demanded advances or concessions. The superintendent grated his teeth, but was powerless. It became known to the men that the company had bought a large amount of material at high prices to cover an extensive line of orders which had been booked, and that it must continue in operation whatever the demands of labor. Among the workmen in more or less responsible positions were several who had not affiliated with the unions. Refusing to do so, their discharge was demanded, and the demand was unconditionally and flatly refused. "We must draw the line somewhere," said the superintendent, "and we draw it right here." The directors did not think the trouble would last long, and so they authorized the superintendent to do as he thought best. A strike followed, and as neither side would yield, week after week passed in idleness. The superintendent turned pale as he saw his purchases of materials coming in and his orders canceled.

He tried to fill up the shops with non-union labor, but his plans were thwarted, and a stranger coming into town had to submit to a cross examination before he could get into the works. Some who had been brought from distant places by the offer of good wages returned voluntarily when they learned the condition of affairs in Linden. Others were frightened away by threats of personal violence; others were given railroad tickets to return home, and but few managed to slip through the pickets and get into the shops, from which they dare not go out. The strike was characterized by more or less violence. On more than one occasion missiles were thrown and pistol shots exchanged. Lawlessness and intemperance gained headway, and could not be controlled. The workmen illustrated, as workmen always do under such circumstances, a capacity for self-sacrifice quite heroic. They would rather starve than yield, if by yielding they acknowledged their subordination to a power always arbitrary and often unjust. So months passed—months of lost profit to the company and suffering and privation for the workmen.

Finally the company yielded, and work was resumed on the terms dictated by the union, but all hope that an alliance for mutual advantage could be formed was forever at an end. The company has lost heavily both in diminished surplus and anticipated profits. Before the costly stock of materials in its storehouse had been worked up, it could have been replaced at much lower prices, and orders canceled were not renewed. Toward the close of 1880, the works were shut down, and have not since been profitably or extensively operated. The other industries of Linden have had varying fortunes, but during the long period of depression they have been idle for a good part of the time. Among the working classes there has been much suffering. Linden has now a large number of dependent poor, as well as much ostentatious wealth. How four fifths of its population live, the remaining fifth cannot guess. No one would now be attracted to it, as its back streets and impoverished, neglected neighborhoods are its principal feature. The wealth which labor created at Linden has largely found investment elsewhere, and but few of those who represented the employing class in 1865 now remain among its residents. The original stockholders of the companies are dead and their families have scattered. Something may happen to revive its industrial activities, but the probabilities are that capital seeking investment will go elsewhere in search of better advantages.

In this parable I have pictured actual happenings. Linden is a type, but we may find such villages all over the country. In briefly recounting its history, I have endeavored to illustrate the practical workings of the wage system, and to show why the wage-earner is dissatisfied. Of the hundreds attracted to the village by the opportunity of work, there were not six, and perhaps not three, who could have profited by the example of the blacksmith, the wheelwright, or the harness maker of the Linden of 1860. It may be said that the troubles, disagreements, strikes, and lock-outs which marked the industrial history of Linden were unnecessary; that during the years of prosperity thrifty and frugal workingmen could have saved something to tide over the intervals of dullness and reduced wages. True, but those capable of exemplifying these excellent virtues would not have gone to Linden in search of employment, or, going there, would not have remained wage-earners. It is no excuse for the oppression of soldiers that some have gained promotion. There must be soldiers as well as officers, and for every man promoted a great many must be enlisted. The problem presented for the consideration of enlightened philanthropy is not how to benefit those whose superior intellectual force or ability enables them to rise unaided, but how to make comfortable and satisfactory the sphere of those who must ever remain "hewers of wood and drawers of water," and establish between them and the employing classes a community of interest and a co-operation for mutual advantage in promoting industrial progress.

In these remarks, necessarily discursive and incomplete, I have endeavored to sketch in bold outline the progress of the labor movement, and to show that, however different the conditions existing in Europe and America may appear to be, the cause of the wage-earner is much the same here as there, with this exception: In Europe political revolution must apparently precede social revolution; here the existing political system is the agency by which social revolution will probably be effected. I have also attempted to present the riddle of the Sphinx as a plain and intelligible proposition. In my next lecture I shall endeavor to show how labor is trying to guess it, and what help can be given toward its solution by those upon whom devolves by right of fitness the duties and responsibilities of industrial command.

A GARDEN AT FALMOUTH.

WE often receive notes from gardens on the Cornish coast, but none has afforded such evidence of the mildness of the climate in that part of the country, says the *Garden*, as the account which Mr. Howard Fox sends us of the kinds of plants which he is able to grow in the open in his garden at Rosehill, Falmouth, all, or nearly all, of which are too tender to thrive in the open about London. The list speaks for itself. The plants which flourish at Rosehill one would only expect to find flourishing in the sunny Riviera. We received the list on New Year's Day. "The following," Mr. Howard Fox says, "are among the most noteworthy which flourish here:

Acacia dealbata, several trees 30 feet to 35 feet high, generally covered with bloom in February.
A. melanoxylon, 30 feet high.
A. lophantha, now flowering.
A. dependens, 15 feet high.
Desfontainea spinosa, 8 feet high, flowers for eight or nine months in the year.
Brugmansia sanguinea, 10 feet high, in profuse bloom in June and again in the autumn.
Aralia Sieboldi, a very free grower.
Abutilon Boule de Neige, 12 feet high. } Against wall protected by yew boughs during frosts.
A. megapotamicum.
A. vitifolium.
Lophospermum scandens.
Citron, Madras, etc.
Fuchsias, many species.
Aloysia citriodora (lemon plant), 10 feet high.
Aster argophyllus, 10 feet to 15 feet high.
Benthamia fragifera, large trees, 20 feet to 25 feet high.
Bambusa Metake, etc.
Ceanothus, several species against walls.
Chamærops excelsa, 12 feet to 15 feet high.
Clematis balearica, etc.
Cordyline australis, 10 feet to 15 feet high, now in seed.
Dracæna indivisa.
Daphne indica.
Diplacus glutinosus.
Eugenia Ugni, bears fruit abundantly.
E. apiculata.
Escallonia, various species.
Eucalyptus globulus, etc.
Habrothamnus elegans.
Hedychium Gardnerianum (flavum).
Hydrangea japonica and quercifolia.
Magnolia grandiflora, etc.
Phormium tenax, now in seed.
Pittosporum Tobira.
P. Mayi, 15 feet to 20 feet high, flowers freely.
Solanum crispum, etc.
Veronica, several shrubby species, 10 feet high.
Woodwardia radicans, self-rooting fronds, 6 feet long.

"At Penmere, one mile from Falmouth, there are eucalypti over 50 feet high bearing seed freely, from which we grow our young plants."

The *Garden* gives an illustration, showing a grove of Dracænas at Rosehill, reproduced from an excellent photograph taken and sent to it by the Rev. A. H. Malan, of Perranarworthal Vicarage, who also says that "the dracænas do admirably hereabouts. I have a large bed of them in this garden, but not so tall as Mr. Fox's, for they are younger than his—it is only a question of time. The D. indivisa is better suited for an avenue than D. australis or than the cross between both, as the two latter send up so many shoots from the base. Mr. Fox has a citron tree on which I saw some ripe fruit last summer. Benthamias and embothriums do well here; of course, also Gunneras and camellias. I have a red-berried solanum which has been established some years here; oleanders do well as to growth, but it is difficult to get them to blossom, though they form buds freely. I had one truss of flowers this past summer. The trees that don't do with us are walnuts, apricots, and deodars."

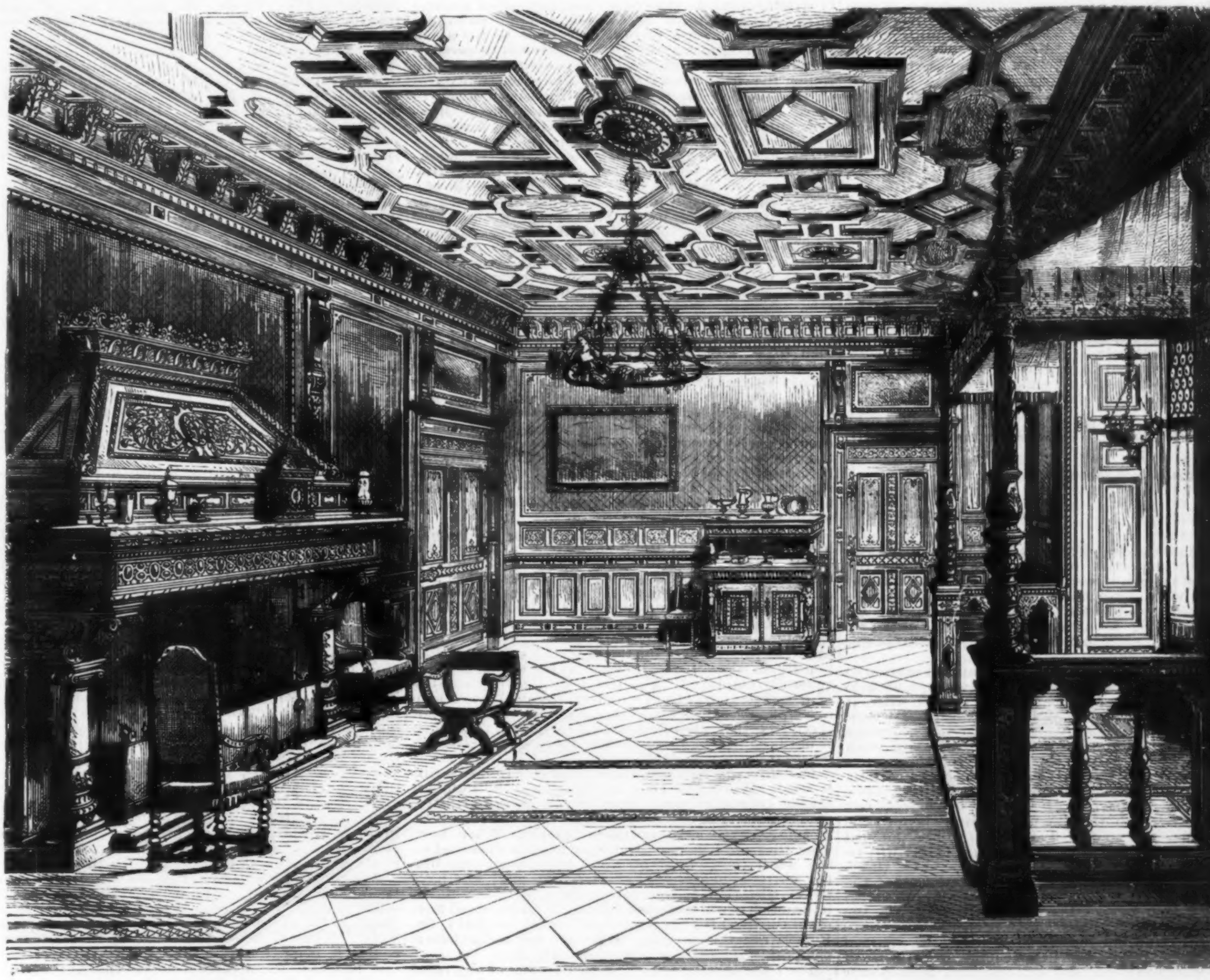
BY the use of delicate scientific instruments, it has been determined that the Washington Monument on a clear day moves at the top two inches, one inch in each direction, east and west, between sunrise and sunset.

ASIATIC CHOLERA.—REPORT OF ENGLISH COMMISSION.

DRS. KLEIN AND GIBBES, in their report on etiology of cholera, make the following objections to the theory of contagion: 1. That the attendants of the sick are, according to all account, particularly exempt. 2. That it is proved by the researches of Pettenkofer and others that, on the introduction of the cholera virus to a new locality, a considerable interval of time elapses before an epidemic. 3. That certain places—*e. g.*, Versailles, Lyons, Birmingham, have shown an immunity when cholera was raging in contiguous towns. 4. That it is a known fact that epidemics die out on board ships that put to sea; and finally: 5. That it is well known in India that the movement of troops from an infected cantonment suffices to check an outbreak among them.

They insist that in order to prove the specific character of the comma baccilli, it must be shown: 1. That they occur exclusively in cholera. 2. That they are present in great numbers in the tissues of the small intestines, so as to produce a large amount of poison. 3. That they differ in all respects from putrefactive bacilli. 4. That the comma bacilli of pure cultivations can produce the disease when introduced into the animal system. Each of these points is dealt with by the reporters. They find great variations in the number of the bacilli, and in some acute cases often had difficulty in detecting them at all. They found large numbers in mucous flakes undergoing putrefaction, an observation directly opposed to Koch's statement that comma bacilli are inhibited and destroyed by putrefaction. They have also found morphologically indentical comma bacilli in the stools of diarrhœa, dysentery, enteric fever, and phthisis; so that to employ the detection of comma bacilli as a diagnostic test is erroneous. Drs. Klein and Gibbes confirm Koch's observation that in acute typical cases the comma bacilli are found chiefly in the mucous flakes of the lower part of the ileum, but consider that it does not harmonize with the assumption that the bacilli are the cause of the disease, seeing that the anatomical changes and amount of flakes and fluid are as marked in other parts of the intestinal tract. But their observations are directly opposed to Koch's upon the important point of the presence of comma bacilli within the mucous membrane, employing the same methods as Koch's. This suffices, they think, to dispel the notion that comma bacilli produce the disease.

Drs. Klein and Gibbes find that acidity does not inhibit the growth of the bacilli in cultures, and do agree that the liquefaction of gelatine occurs in an especially peculiar manner. They examined the water from the tank in Calcutta which, according to Koch, was the focus of infection during an epidemic, and also from other tanks, and found abundance of comma bacilli therein, while no cholera prevailed among the natives, who used the water from the tanks for drinking and other purposes.—*Lon. Lancet*



PARLOR IN THE GUTMANN VILLA, BADEN.—DESIGNED BY A. v. WIELEMANS, VIENNA.—*From Architektonische Rundschau.*

ISOCHROMATIC NEGATIVES FROM PAINTINGS WITH OR WITHOUT YELLOW SCREEN.

By Dr. H. W. VOGEL.

IN the Transactions of the Photographic Society of Great Britain I read an interesting article of Mr. Bird on Braun's negatives of pictures in the National Gallery. It is well known that M. Braun's negatives are what is called isochromatic, and it is certainly interesting to hear how they are produced. Mr. Bird gives not much information regarding this matter, and therefore I beg to say a few words on the subject.

According to Mr. Bird's communication, M. Braun asserts that he uses collodion, but not any aniline dyes in it. Now, I have had an opportunity of examining some of Braun's original negatives, taken here in the museum, and so ascertained that they contained eosine; therefore it is certain that their isochromatic qualities are due to this substance, and that the whole process of M. Braun is similar to my wet eosine collodion process, published two years ago, and employed to a great extent by Hanfstangl (Munich) and others.

Mr. Bird says that Messrs. Braun use a *couche* for the purpose of modifying the complementary colors. I give herewith a formula which allows the work to be done without such *couche* (*i. e.*, a yellow glass) in many cases.

1. *Collodion.*—*a.* 1 gramme of eosine dissolved in 360 cub. cent. alcohol. *b.* 2 grammes bromide of cadmium dissolved in 30 cub. cent. of eosine alcohol (*a*), filtered and mixed with 3 volumes of *c*. *c*. 1 grain eosine solution in 360 cub. cent. of plain collodion, containing 2 per cent. cotton (Schering's celloidin collodion), and let it settle thoroughly.

2. *Silver Bath.*—*a.* Dissolve 300 grains nitrate of silver in 1,000 cub. cent. of water, and add 40 cub. cent. of glacial acetic acid. In this bath the plate with collodion (No. 1) is silvered six to eight minutes, then transmitted to the second silver bath, *b*.

b. Nitrate of silver	50 grains.
Water	800 "
Nitric acid (sp. gr. 1·22)	6 drops.

In this second bath the plate remains two to three minutes.

3. *Exposure.*—The time of exposure is very different, according to the nature of the colored subject. A painting in water colors I expose, with Aplanat fourth stop, on clear days, about four minutes; oil paintings twice as much; subjects with dark blue I expose in daylight without any yellow glass; but for pictures with brilliant colors I prefer a yellow plate glass, which I put before the object glass or behind it, inside of the camera. The best yellow screens I prepare in the following manner: Dissolve 3 grains aurantia in 2,000 cub. cent. collodion, with 1¾ per cent. cotton, and coat with this collodion a piece of well cleaned plate glass, and let dry.

This aurantia collodion I dilute occasionally with half or whole of its volume with plain collodion, and coat the glass plates with it. So I get screens of different intensities. For many cases, a pale yellow screen is sufficient. Practical knowledge is the only guide here.

4. *The Developer and Redeveloper* are exactly the same as those used in the ordinary wet process; also,

5. *The Fixing Bath and Varnish.*

The illumination of the dark room should be deep orange, and the plate should be sensitized in the shadow of the orange light.

Allow me to add here some words regarding the discussion on this matter at the meeting of the Photographic Society.

It is true Herr Angerer, in Vienna, takes negatives after paintings with ordinary dry plates by interposing an orange screen, but it is not true that these negatives are isochromatic in the ordinary sense. M. Angerer uses an orange screen for cutting out certain colors from the action of light, *e. g.*, the blue rays, so he gets a negative which yields by his phototyping process a printing block showing the blue color according to the principle of Vidal and Ducos du Hauron. M. C. Angerer tells that he uses highly sensitive plates for that purpose, and that he believes the isochromatic qualities of azaline and other plates should be due only to their high sensitiveness, not to the dye mixed with the emulsion at all.

It is possible to make the least sensitive plate isochromatic by the addition of dyes. I have made isochromatic even chloride of silver collodion by the addition of Magdala red, though chloride of silver in collodion is about one hundred times less sensitive than gelatine bromide of silver. I have published my experiments with this subject no less than eleven years ago (*Photographische Mittheilungen*).

DEPOSITION OF TIN UPON FABRICS.

A NEW process has recently been invented in Germany, whereby a flexible and brilliant coating of tin may be deposited upon fabrics. A paste is first formed of commercial powdered zinc and egg albumen, and this is spread over the fabric by means of a brush. This paste is then coagulated, after drying, by a current of superheated steam. After this the fabric is immersed in a bath of perchloride of tin. The metal is precipitated upon the zinc in a finely divided state, and the article, after being rinsed and dried, is passed between cylinders, which gives a brilliancy to the layer of tin. Very beautiful results are obtained by leaving white spaces on the fabric, and thus forming metallic designs, which are much preferable to those cut out of tin foil and pasted upon the goods.—*Annales Industrielles.*

THERE is no more simple and efficient mode for clearing waste pipes of impurities than hot, strong lye. It dissolves the greasy sediment, and does not injure the pipe.

PNEUMATIC TUBES.

The pneumatic tubes used in Great Britain are made of lead, and when laid beneath the streets they are inclosed in iron pipes for protection. The tubes vary in length from two miles downward, the average length being about ¾ mile. The diameter of the longer and more important tubes is 3 inches, and that of the shorter and less important tubes 2¼ inches. The carriers within which the messages are sent through the tubes are made of gutta percha tubing, covered with felt, and have a head of several pieces of felt which accurately fits the tube. The carriers used with the 3 inch tubes weigh about 7 ounces, and will contain about 36 messages; those used with the 2¼ inch tubes weigh about 2¾ ounces, and will contain about 12 messages.

Each of the tubes is provided with a simple electrical contrivance by which the departure from and the arrival at each station of the carriers is signaled.

The power by which these tubes are worked is derived from steam engines located at the central office. These engines work air pumps which either take air from the atmosphere and compress it to a smaller volume and then discharge it into the pressure main, whence it is admitted by means of taps into the different tubes when carriers are dispatched to an out-station, or the pumps take air from the vacuum main, compress it to the atmospheric pressure, and then discharge it into the atmosphere; the air in the vacuum main is, of course, being continually renewed by the air which flows from the atmosphere through the tubes into the vacuum mains during the transit of the carriers from the out-stations.

The velocity with which the carriers travel is usually between $\frac{1}{3}$ and ½ a mile per minute. The approximate time of transit in minutes through a tube of L miles = 2·7 $L^{\frac{3}{4}}$ with the 2¼ inch tube, and 2·1 $L^{\frac{3}{4}}$ with the 3 inch tube.

The energy expended in driving a carrier from the central office to an out-station is equal to the volume of compressed air which flows into the tube during the transit multiplied by the work required to produce a unit volume of compressed air.

The volume of compressed air which flows into the tube during transit is equal to about ⅘ of the tube's cubical capacity. The capacities of the 2¼ and 3 inch tubes are 146 and 251 cubic feet per mile respectively, so that the volumes of compressed air used in driving a carrier through a mile of each tube are 125 and 200 cubic feet respectively.

The work required to produce a cubic foot of compressed air at a pressure p_1 from a pressure p_0 lies between the isothermal value

$$0{\cdot}01005\ p_1 \log.\frac{p_1}{p_0} \text{ horse-power minutes,} \qquad (1)$$

and the adiabatical value

$$0{\cdot}01505\ p_1 \left\{ \left(\frac{p_1}{p_0}\right)^{29} - 1 \right\} \text{horse-power minutes.} \qquad (2)$$

So that to produce a cubic foot of compressed air at a pressure of 12 pounds to the square inch above the atmospheric pressure would require between 0·0695 and 0·0755 net horse-power minute, or say about 0·085 gross horse-power minute; and, therefore, the energy expended in driving a carrier through a mile of the 2¼ and 3 inch tubes would be 10·6 and 17 horse-power minutes respectively.

When a carrier is dispatched from an out-station to the central office, the air in the tube first expands into the vacuum main and thence into the pumps, where it is compressed to the atmospheric pressure and then discharged into the atmosphere. By the aid of formulæ 1 and 2, it is found that the gross amount of work of 0·065 horse-power minute is required to pump a cubic foot of air into the atmosphere from a vacuum main at a pressure of 8 pounds per square inch below the atmospheric pressure. If the tube has been at rest immediately before the carrier is dispatched to the central office, the volume of air which will be pumped into the atmosphere from the vacuum mains will be equal to the cubical capacity of the tube; and, therefore, the energy expended in the transmission of the carrier would be 8 and 13 horse-power minutes with 2¼ and 3 inch tubes respectively. If, however, the tube had immediately previously been used to receive a carrier from an out-station, there would be a partial vacuum in the tube, and, therefore, the expenditure of energy would be less, say 6½ and 10½ horse-power minutes respectively. But if, on the other hand, the tube had just previously been used to dispatch a carrier to an out-station, it would be partially filled with compressed air; and the amount of work which the pumps would have to perform would be greater, and the amount of energy expended during the transit of the carrier would be about 12 and 19 horse-power minutes with the 2¼ and 3 inch tubes respectively.

These amounts of energy would be expended in several different forms. First, work would be performed in pushing back the atmosphere at that end of the tube at which the pressure was lowest; secondly, energy would be expended in generating mechanical vibrations of the tube; and, thirdly, in overcoming the friction of the carrier within the tube. The first of these quantities is much the greatest, and is equal to about ¾ the net work of the engine in pressure working, or about ⅓ the net work of the engine in vacuum working.

The energy expended in overcoming the friction of the carrier may be approximately calculated from the formula

$$\frac{W \cdot L}{150} \text{ horse-power minutes,}$$

where W is the weight of the carrier in ounces and L length of tube in miles.

Thus, with the 2¼ inch tube, the energy expended in overcoming the friction of the carrier through a mile of tube would be about $\frac{1}{15}$ horse-power minute, or with the 3 inch tube about $\frac{1}{18}$ horse-power minute. So that the energy expended in overcoming the friction of the carrier itself would be only $\frac{1}{165}$ to $\frac{1}{175}$ of that expended in expelling the air from the tube.

The expenditure of energy in the transport of a pneumatic carrier is enormous as compared with other methods of transportation. Thus, with the same expenditure of energy, a locomotive will transport as many tons upon a railway as a pneumatic tube will transport ounces. The use of pneumatic tubes for transport purposes is indeed so wasteful of energy that it has completely failed to be practicable, except in pneumatic telegraph transmission; and it is possible that even for telegraphic purposes pneumatic tubes may be ultimately superseded by some more economical system.—*W. Moon, Electrical Review.*

[The Garden.]

MEASURING TIMBER.

The question of measuring timber, upon which "R. P." asks for enlightenment, has from time to time been referred to in these columns, but as it is a subject of general interest, and one which is not too well understood, some further information as to the most common methods may be acceptable. In minor details practice no doubt varies in different districts, but, as a whole, the following remarks are of general application.

The System of Measurement.—In selling unhewn or unsawn timber off an estate, the system known as quarter girth string measurement is almost always adopted. By some the tape is used in place of the string, but, even when this is done, the terms are virtually synonymous, as the system is denominated quarter girth string measure, in contradistinction to caliper measure. There are certain objections to the use of the tape in obtaining the girth, which will be presently referred to; but for taking the measure of standing timber the string is not suitable. The essential features of this method are ascertaining the length of tree in lineal feet and its circumference in inches. Before, however, entering upon this it will be well to say a word as to the equipment required by the measurer.

The Measurer's Implements are few, but the following are indispensable. For measuring standing timber, a rod and leather strap. The rod may consist of a single length of light tough wood some 13 feet long, or may be made longer by means of joints, in which case the individual lengths would not be so long, to admit of more easy carriage. The strap may consist of a piece of leather some 6 or more feet in length, according to the size of the timber to be measured, and be somewhat of the character of an ordinary carriage rein. As it is difficult to get straps of this kind marked ready for use, the measurer will do well to prepare it himself. To one end of the strap a ring of from an inch to an inch and a quarter in diameter should be attached, and from this ring spaces of four inches should be plainly set off along the whole length of the strap. Within each of these spaces four other spaces of 1 inch each must be marked. As will be presently seen, each of these 4 inch spaces represents an inch of quarter girth, and each of the inch spaces within these the fractions of an inch in quarters. It will therefore be necessary that at the first 4 inch division from the ring the figure 1 be marked in, at the second 4 inches a figure 2, and so on at each 4 inch division along the whole length of the strap.

For Measuring Felled Timber a 66-foot tape (which, however, will require the presence of an assistant) or a 5 foot rod may be used to ascertain the length of the tree. The tape will, of course, be marked in feet and inches, but if the feet and half feet are marked on the rod, which may be made of deal, it will be enough. As has been said, the tape is sometimes used to get the circumference to obtain the quarter girth, but as it takes in excrescences on the tree and otherwise does not lie so closely on the bark as the string, it is not generally employed. The string itself merely consists of a sufficient length of whipcord fastened into a loop a couple of inches long at each of its ends. A knot should be tied a few inches from each loop, that when it has been passed under the tree the point in its length where it meets may be known.

For Marking the Trees either paint or a timber scribe is used. When the trees are standing, the numbers cannot be readily made clear by the marking instrument, so paint is generally used, and the trees numbered consecutively in the ordinary rotation. When, however, they are felled and the figures can be inscribed on the wood itself—in most cases on the butt—the timber scribe is more often adopted. To most who have to do with timber, this instrument is familiar; and as in practice it will be found difficult to form curved lines upon the hard butt of a tree endwise of the grain, the Roman notation is often called into use, as the letters composing it mostly consist of straight lines.

The Dimension Book.—This may consist of any ruled book of a convenient size for the pocket, and must be ruled into four vertical columns. The first of these will be for the number of the tree; the second, for its length in feet; the third, for its quarter girth in inches and fractions of an inch; and the fourth, for its contents in cubic feet and inches. The book of tables by which the contents are found will be spoken of later on, as it is not necessarily a part of the equipment in wood or field. What has been mentioned hitherto the surveyor must carry with him in his work, but, as will be seen, the tools will be slightly different, according to whether the timber is standing or felled.

To Measure Standing Timber.—Either the 13 foot or the jointed rod, and the leather strap will be necessary. When the number has been affixed to the tree, the first business will be as nearly as may be to ascertain its height in feet, and to do this, if the 13 foot rod be used, as an ordinary man reaches about 7 feet, 20 feet of its height is at once fixed. If the trees are not very large or tall, the distance of measurable timber above this can be readily estimated after a little practice, and entered in the dimension book on the same horizontal line as the number and in the column next to it, viz., the second. If, however, the trees are very high, it may be well to use the longer jointed rod, as to judge the length of a tree when this is the case requires a good deal of experience. When the height has been satisfactorily fixed and entered, the next business will be to ascertain the quarter girth, and to do this correctly is a more difficult thing than to estimate the length. In measuring timber, whether standing or felled, the object of the measurer is to ascertain the circumference, and from this the quarter girth, of the tree at a point equidistant from each end. When it is lying on the ground, this is obviously easy enough; but when it is standing, it is a different matter. If the leather strap which is used for this purpose could be passed round the tree at half its timber height, the dimensions would be found very nearly; but as this would necessitate the use of a ladder at each tree, which is a very tedious process, the plan generally adopted is to take the measurement about breast high, and estimate from this what the size is at half the height. To do this requires some discretion, and if a ladder is available it is a very good plan to occasionally test the judgment, as an inch or two error in girth is more important than a foot of length. The allowance for bark would be the same whether standing or felled, and will be treated of in its proper place. I have here assumed that the trees are of irregular growth, such as are commonly found in fields or hedgerows, and are dealt with individually; but as trees growing in woods and plantations, especially larch, scotch, and spruce, are tolerably uniform in height and size, in many cases the average of the trees can be struck and only a few measured, the bulk being estimated from these.

The Measurement of Felled Timber is, of course, much more accurate. As has been said, the length of a felled tree can be ascertained by the tape if an attendant is at hand, or if not, by means of the 5 foot rod, which can be manipulated by the measurer himself. When the tree has been numbered, this is set down in the dimension book as with the standing tree, and the quarter girth, when found, as should have been stated above, entered in the third column on the same horizontal line. To find the quarter girth of a felled tree the string is passed underneath it at half its length and when withdrawn folded twice, so that the quarter of its circumference may be read off on the rules and entered as described. It must, however, be clearly understood that to take the entire timber length of a tree and its quarter girth in the middle does not necessarily give its cubic contents. If the tree tapers gradually from end to end, this would be the case; but if it suddenly drops off in size at two or three points in its length where a large branch has grown out, another plan of measurement must be used, viz., to take its length in sections, say from the butt to where the first large branch occurs, from there to the next sudden fall in size, and so on. Each of these lengths must be treated as though it were a separate tree, and girthed accordingly. Sometimes on making sales the larger portions of a tree will go at a higher price and the smaller at a lower. This, of course, makes no difference in the manner of measurement, but the entries must be kept distinct.

To Calculate Contents.—When the length and quarter girth of a quantity of timber have been taken, the cubic contents have to be worked out, and as to calculate every separate item would entail a large amount of labor, a set of tables is almost always referred to. These are contained in "Hoppus' Measurer," a book which costs about 2s. In this book there are various sets of tables, but the one which affects us now is that given as solid measure. In this the quarter girth in inches and fractions of an inch is given at the top of the page, and the lengths in feet in the first vertical column. If, for instance, a tree was 25 feet long by 12 inches quarter girth, the 12 inches will be found at the top of the page, and as each foot in length in this case represents a cubic foot, the measurement opposite the 25 will be found to be 25 feet. To find this by calculation, square the quarter girth, multiply by the length in feet, and divide by 144. Thus 12×12=144×25÷144=25 feet.

Allowance for Bark.—In measuring all timber, with the exception of oak, which is generally stripped of its bark, an allowance has to be made for this. When the bark is thick, as in the case of the elm, poplar, etc., a larger allowance should be made, but when thinner, as with the larch, ash, beech, etc., so much is not required. The way in which the allowance is made may be left pretty much to the taste of the measurer. With some it is the practice to allow an inch to a foot of quarter girth, and this almost irrespective of what kind of timber, taking one with the other. When this is done, the allowance is made of each dimension as the work proceeds, a 12 inch quarter girth on the bark being set down as 11 inches. Another and perhaps a better plan is to enter down the gross figures as the work proceeds, and then at the close strike off a percentage ranging from 10 to 15, according to the kind of timber and the thickness.

Allowances for Defects.—This is a thing which should be mutually agreed upon between the buyer and the seller as each tree is come to. When timber is sold standing the buyer generally takes the risk of unsound wood. When a defect can be seen, an allowance, of course, is made, but as very frequently a tree will turn out unsound when there is no external appearance of anything of the sort, standing timber is not, as a rule, estimated to the extreme limit. Defects, of course, occur in a variety of ways, but the most common are shakes and dead knots. When a tree is absolutely hollow, it is almost always better to agree with the merchant for a lump sum than to attempt to measure it. When it is unsound for apparently a short distance only, it is usual to take the dimension at or so much shorter length as will allow for the defect. A certain amount of experience is requisite to fix a proper quantity to be allowed. When a tree is unsound at the butt, and there is no indication of unsoundness where the branches have been cut off, or at the top, it may almost be taken for granted that it will again become sound at a foot or so above the distance to which a rule or rod can be inserted; but if the defect appears where the branch is severed and at the top as well as the butt, it may be taken that there is very little good wood in the tree. In cases of decay which has set in at the top or branches of the tree and it has become hollow, there is always more doubt as to how far the fault goes, and a larger allowance will be necessary to cover the risk the buyer has to run.

Quarter Girth and True Contents.—If a little thought is given to the subject, it will be seen that the quarter girth does not give the true contents of a tree, as if it was hewn square the side would theoretically be the same and the contents the same, after all the convex portion of each side had been removed. The difference between the quarter girth and the true contents is some 25 to 27 per cent., and at first sight this appears like giving an undue advantage to the buyer. In reality it is not so, as it is only sufficient to cover the loss of chips and slabs in cutting up. As a matter of fact, other systems of calculation have been tried; but though theoretically incorrect, the 144 division has stood its ground, and will probably do so for a long time to

come, as if another were adopted giving a greater content the prices would be correspondingly lowered, and all the alteration would effect would be to rob Peter to pay Paul. The whole thing, however, is one of the most important in practical forestry, as it is exceedingly easy, from an imperfect knowledge of how to measure, to lose years of growth in a fall of timber. This must be accepted as my reason for occupying so much space with my remarks upon it. Even now there are many things upon which I have been unable to dwell fully, but I hope I have made the general principles clear. If there is any point which has not been sufficiently explained, I shall be glad to endeavor to make it clearer if desired. D. J. YEO.

NEW ANALOGIES BETWEEN ELECTRIC PHENOMENA AND HYDRODYNAMIC EFFECTS.

Various Hydrodynamic Imitations of the Electric Brush.—The electric aigrette or brush is one of the

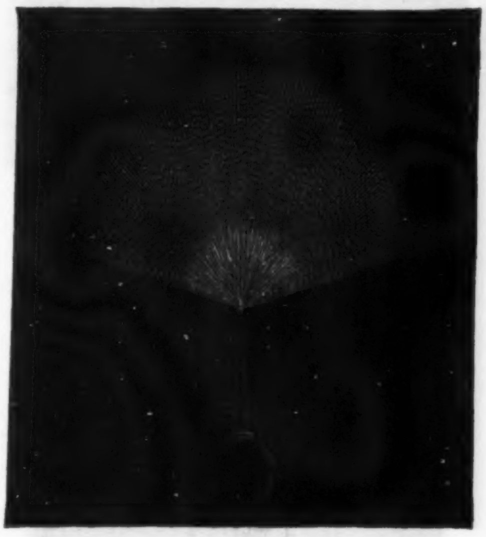


FIG. 1.—ELECTRIC AIGRETTE.

physical phenomena of electricity most capable of hydrodynamic imitation. Among the means of imitation I shall cite the following. When we fit a small rubber tube, about four inches in length, to a service-pipe of the city water-supply, the tube will begin to

FIG. 2.—HYDRAULIC AIGRETTE.

vibrate spontaneously, with a velocity and amplitude that will be so much the greater in proportion as the current is stronger. The jet will produce a sort of fan composed of a multitude of radiating, equidistant streamlets consisting of very perceptible droplets. This

FIG. 3.—ELECTRIC SHEET.

phenomenon is analogous to that of the electric aigrette that escapes through a point arranged upon an ordinary electric machine, as is shown by the two comparative figures (Figs. 1 and 2).

Another form of aigrette, or rather of electric sheet, is that shown in Fig. 3, and imitated hydraulically by the sheet of liquid produced by the expansion of a horizontal stream when it chances to strike a resistant plane with a certain velocity. It will be seen that there is a striking analogy between these two forms. We might cite various others of the same kind.

The aureola (Fig. 5), produced by a vertical jet of liquid striking a small horizontal plane, finds an analogy in that produced by an electrical jet in which the discharge falls back against a pane of glass; or, again, in Gassiot's luminous cascade experiment.

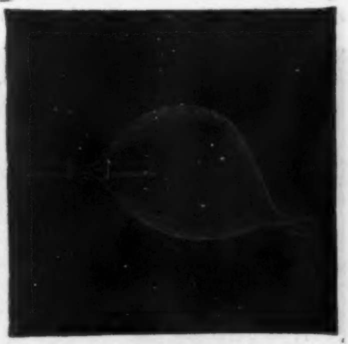


FIG. 4.—HYDRAULIC SHEET.

Again, the electric aigrette can be imitated by blowing a column of liquid (Fig. 6) or air (Fig. 7) through a tube, upon a plate covered with a deposit of moistened red lead, or by blowing a light powder (lycopodium) upon a very dry pane of glass.

The kind of aigrette that the compound electric spark constitutes is analogous to the current of water that escapes through the rose of a watering-pot.

I shall cite further, as connected with the present question, stellate and sinuous sparks, whose well known

FIG. 5.—AUREOLA.

forms are imitated by suction through a fixed tube (Figs. 8-10.)

Electric Figures.—On producing a discharge from a Leyden jar upon an insulated glass sphere, and then immediately throwing upon the electrified surface a mixture of sulphur and red lead, Mr. Antolik forms figures among which I remark the following: A metallic point is placed opposite the sphere, and receives an electric discharge through its other extremity, which terminates in a ball. The resulting figure is circular with radiating edges. If the point be inclined, the

FIG. 6.—AIGRETTE FROM BLOWING WATER.

annular figure will possess an elliptical or ovoid form. Such effects are easily imitated by hydrodynamic way by strong suction through a tube $\frac{1}{16}$ of an inch in diameter, in contact with a plate covered with a very thin layer of red lead and water. If the tube be oblique to the plate, the radiating figure will be of more or less elongated elliptical form.

Hydraulic Imitation of Electric Shadows.—The phenomenon of electric shadows studied by Crookes and Holtz has been quite simply reproduced by Mr. Righi, by placing in the pathway of a spark from a battery a narrow, non-conducting body, which leaves upon the ebonite plate that it touches certain traces that are revealed by a mixture of red lead and sulphur. These traces are the positive or negative images of the more or less diminished form of the intermediate obstacle.

FIG. 7.—AIGRETTE FROM BLOWING AIR.

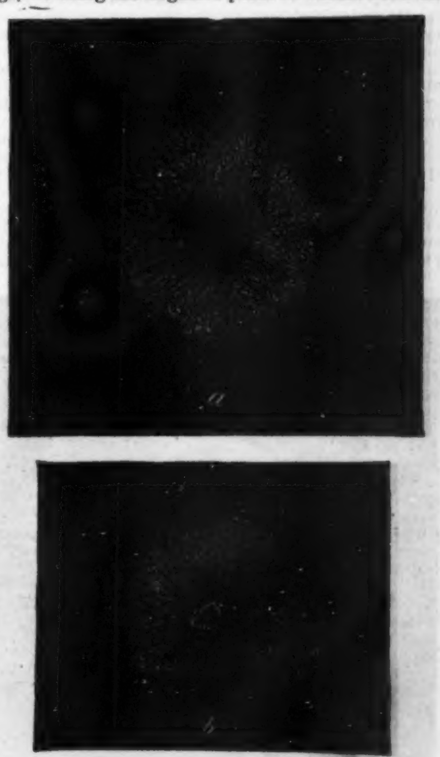
This result is easily imitated by hydrodynamic way, by placing between the liquid current and the glass plate a narrow object, such as a stiff, rectilinear, curvilinear, simple or double wire, whose form is projected, like the shadow of the object, upon the plate.

Fig. 11 represents the hydraulic ring projected without obstacle upon the glass plate, covered with a layer of aqueous minium. In Fig. 12, obtained with the same tube, with an equal column of water falling from the same height as in the preceding experiment, the wire that forms an obstacle to the shadow is placed in the direction *ab*. The elongation of the figure occurs in the same direction.

The interposition of the edge of a pane of glass in the situation *abcd* has the effect of elongating the figure perpendicularly to the direction of the edge, and of diminishing its width, as shown in Fig. 13. In Fig. 14 it is the angle *abc* of the plate that forms an obstacle to the fall of the liquid column. There is also an elongation in a direction contrary to the apex of this angle, and a diminution of width in the figure.

We should obtain analogous results by employing an atomized liquid jet, or a jet of fine powder blown upon the obstacle arranged near the plate.

Electric Shadows upon Nobili's Colored Rings.—I have carried the observation of electric shadows farther in trying to ascertain their effects upon electro-chemical rings. As well known, in order to produce these rings, we bring the negative point to within a few lines



FIGS. 8 AND 9.—HYDRODYNAMIC IMITATION OF A STELLATE ELECTRIC SPARK.

of a metallic plate that communicates with the positive pole of a pile or induction apparatus. When, between the point and the plate, we arrange upon the path of the electric current, or upon the plate itself, one or several glass threads, a metallic needle, or a small plate a few lines square, the rings produced have

on their faces an empty space that represents the projection of the intermediate object upon the plate (Figs. 15 and 16). If the negative point chanced to touch the conductor, the latter would then act as if it formed part of the electrode, and the rings would correspond to the total form of such anode.

Imitation, by Hydrodynamic Way, of Sparks from a High Tension Electrical Machine.—Some water is put into a vertical cylinder whose bottom contains several fine apertures. A piston that touches the water receives an impact, and the sudden pressure causes the liquid to

FIG. 10.—HYDRODYNAMIC IMITATION OF A SINUOUS SPARK.

spurt with force. This water is received upon a plate covered with aqueous red lead, which preserves the imprint of the jet.

The water, again, can be thrown in quite a strong jet when we blow the liquid abruptly and strongly upon the plate. The effect would be more pronounced with compressed air.

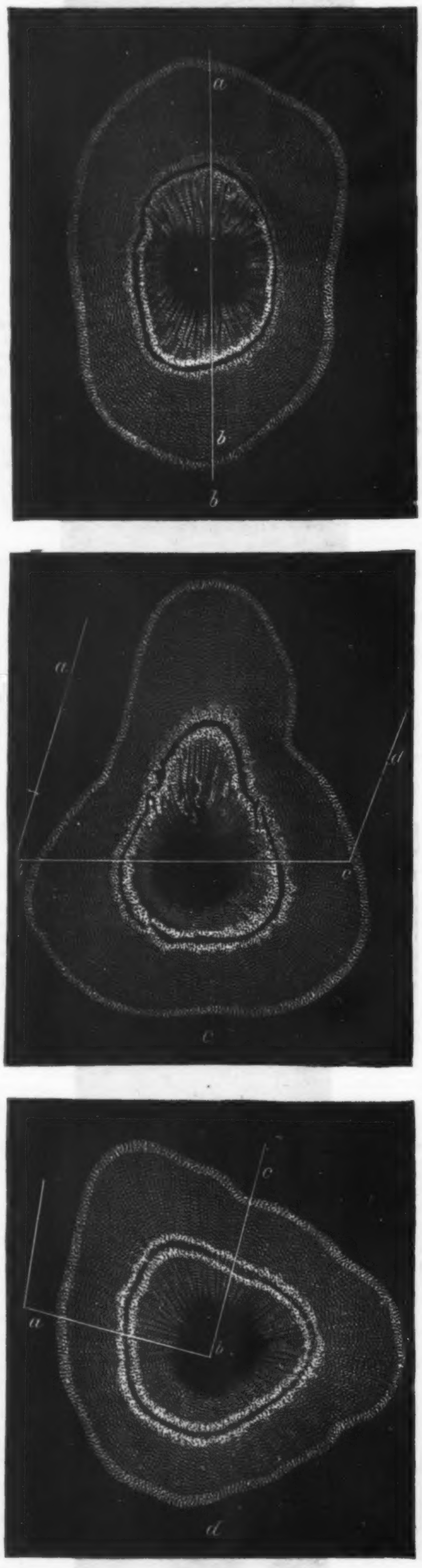
Imitation of Various Sorts of Electric Discharges.—Mr. Feddersen, of Leipzig, in his researches relative to the sparks produced by the discharge of electric batteries, distinguishes three sorts of discharges, to wit: (1) an intermittent discharge, in which the electricity successively escapes in isolated sparks, and as if drop by drop, an effect easy of imitation by moving the tube horizontally and quickly, while the liquid it contains is flowing over the pulverulent deposit; (2) a continuous discharge, in which the electricity flows through the circuit conductor, and forms a non-interrupted current until its exhaustion. The imitation of this is easy, since it suffices to move the tube parallel with the plate, and quite low down. The furrow will be continuous if the height of the fall is such that the stream of water reaches the plate before the interruptions of the vein. (3) an oscillating discharge, which occurs when the latter is oscillating from one armature to the other of the battery with a gradually decreasing

FIG. 11.—HYDRAULIC RING.

intermittence. The figures obtained by Mr. Feddersen are numerous, and vary with the nature of the metal used. Some are found in the form of multiple W's, or of longitudinal bands, which our hydraulic experiments are capable of imitating quite well.

It would be easy, by hydraulic way, to imitate the cascade of fire experiment produced by a flow of electricity over a uranium glass and saucer covered with sulphate of quinine, the whole being covered with a pneumatic bell traversed by a metallic rod that communicates with one of the poles of the induction apparatus, while the plate is connected with the other pole. When the induction spark, a product of the positive pole, reaches a liquid surface, it ramifies in the mass of liquid in delicate fibers like the roots of a tree, and the center of the ramifications has the form of a disk.

A drop of ink let fall from a height of two inches

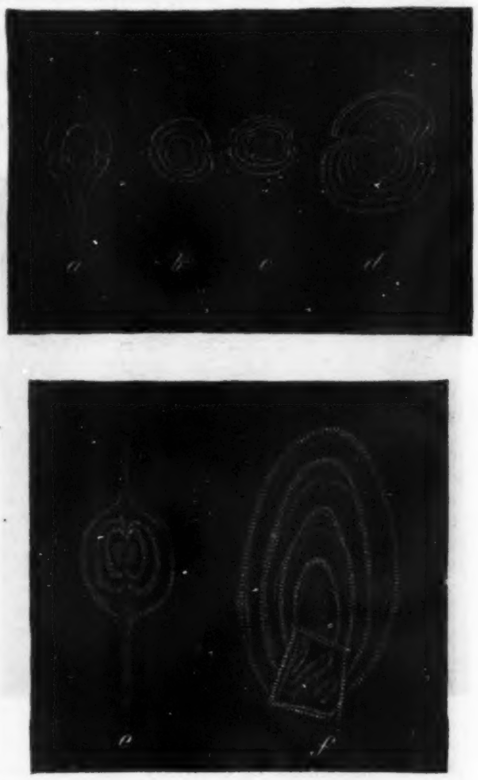


FIGS. 12, 13, AND 14.—HYDRODYNAMIC IMITATION OF ELECTRIC SHADOWS.

upon the surface of some water in a vessel very well imitates these effects of arborization in the liquid mass. These effects are again easily imitated by sucking from the glass plate, with a pipette, the liquid that holds red lead in suspension.

Imitation, by Hydrodynamic Way, of the Mechanical Effects of Electricity.—The mechanical effects produced by static or dynamic electricity are easy of imitation hydrodynamically, since they approach ordinary mechanical effects, in our way of considering the electric flux as a liquid or material one. It is thus, for example, that we imitate the effect of Kinnerley's thermometer, by substituting for the shock of the electric spark the impact of a column of water falling upon the liquid of the apparatus, or by employing the impact of air abruptly blown by means of a tube.

Experiment in Breaking Tubes.—When the discharge from a Leyden battery is caused to explode in a glass tube filled with water and closed by two corks that are traversed by two rods terminating in balls within the tube, the latter will break into a large number of pieces through the suddenness of the shock. A like discharge produced in an open goblet of water, the two metallic balls being near the sides of the vessel,



FIGS. 15 AND 16.—ELECTRIC SHADOWS ON NOBILI'S COLORED RINGS.

will likewise break the latter. This experiment I have tried many times.

An analogous effect is produced mechanically by the passage of a bubble of air through a tube full of water. This tube, which should be from 1½ inch to 3 inches in diameter (a lamp chimney will do), is exactly filled, and

FIG. 17.

is closed at its extremities by simple membranes (bladder) that are firmly fixed.

Through the disruptive effect of the bubble traversing the tube lengthwise without touching the sides, the tube will be shattered, and often broken in fragments in a longitudinal and transverse direction.

Hydrodynamic Imitation of the Effect of the Passage

of an Electric Current into a fine Wire.—When a sufficiently strong electric current passes from one conductor into a narrower one or one of less conductivity, (for example, into a fine wire), it heats it red hot, melts it, or volatilizes it, according to the diameter, length, and nature of the said conductor.

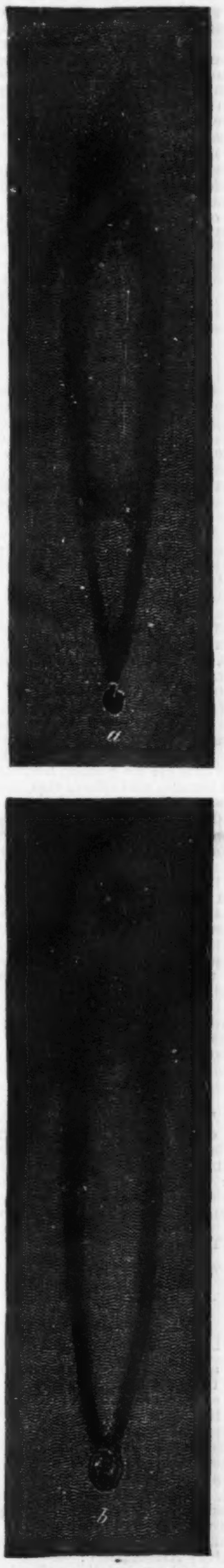
An analogous effect is produced when a strong liquid current is passing from one tube to another and narrower one. If this latter be short and of thin rubber, and if, moreover, it be free at one extremity, it will bend and rapidly vibrate. If it be fixed at the two extremities, and but slightly taut, it will undulate, expand, and finally burst.

If the electric current be insufficient to melt the wire, and merely capable of raising it to incandescence, there will form, at different points along its length, bends and sharp angles that will be so much the more numerous in proportion as the wire is more or less taut. Mr. G. Plante, who has obtained such bends by means of the current from his rheostatic machine arranged for quantity, and with wire $\frac{1}{16}$ in. in diameter and $1\frac{3}{4}$ in. in length, compares them with the vibratory nodes of a cord.

FIGS. 17, 18, AND 19.—IMITATIONS OF THE FORM OF WATERSPOUTS.

It seems to me that this bending into angles can be explained by the fact that the different parts of the same electric current repel each other. The effect is so much the more obvious in proportion as the wire is less taut. Were the wire free at one extremity, and the other touched some mercury or acidulated water communicating with the pile, or were capable of sliding along a metallic rod, it (the wire) would take on recoiling motions analogous to those of the rubber tube of my experiments on liquid currents—results similar to that which obtain when a suspended wire helix touches, through its lower extremity, a large drop of mercury covered with acidulated water. A recoil motion takes place in the mercury and helix every time the latter happens to touch the former, and this alternating motion is explained by the repulsive action upon themselves of the various parts of the current.

As the spark is the route followed by electricity through the air or gases, it must behave as a current. In fact, it does exhibit zigzags analogous to the bends in a fine wire that is being traversed by an electric current. Doubtless it is expedient to here take into account the presence of the more or less conductive particles that are irregularly disseminated in the gaseous media traversed by the spark; but these media are perhaps no more heterogeneous than the molecular ones of solid bodies.



FIGS. 20 AND 21.—HYDRODYNAMIC IMITATION OF THE FORM OF COMETS' TAILS.

Hydrodynamic Imitation of the Polarization of Liquids by Electric Currents.—Upon this subject Faraday experimented as follows: Two pointed metallic rods passed through the opposite sides of a glass vessel containing rectified spirits of turpentine up to a level a little above the horizontal points, and silk fibers were thrown upon the liquid. One of the rods was connected with the conductor of an electrical machine, and the other was in communication with the earth. As soon as the machine began to operate, the discharges continuously traversed the liquid, and the fibers were observed to hasten from all parts of the surface of the turpentine, unite end for end, and form a true chain between the metallic points. As long as the passage of electricity lasted, this arrangement persisted, and the fragments even offered great resistance when an attempt was made to separate them by means of a glass rod. But as soon as the machine ceased to operate, the chain broke up of itself, and the floating filaments dispersed. Faraday concluded from this that the silk fibers were in the same condition as the particles of wire that arrange themselves in a linear series between the poles of a horseshoe magnet, and that their polarity represented the state of the molecules of the turpentine itself during the passage of the electricity. Mr. Matteucci repeated this experiment, and replaced the silk fiber with tenuous powders held in suspension in the liquid, and on every occasion observed this linear arrangement to occur between the two points.

In order to imitate this polarization of the liquids hydraulically, there will be little change to make in the arrangements of the preceding experiment. It will

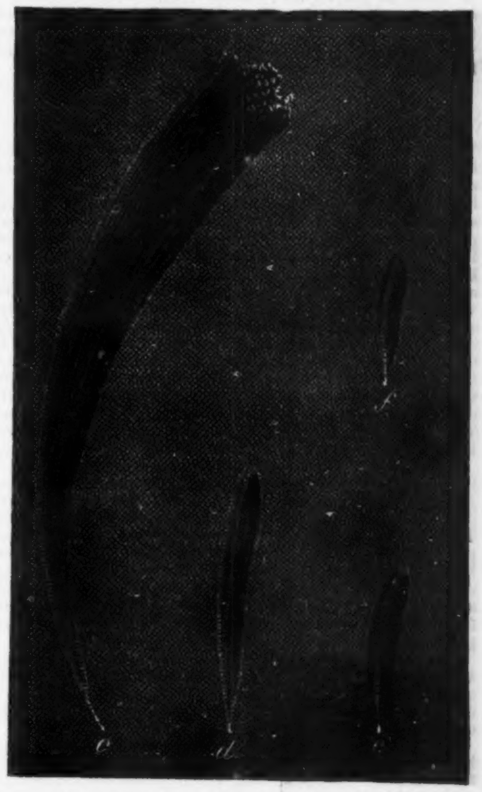


FIG. 22.—MECHANICAL IMITATION OF THE FORMS OF FIRE BALLS.

suffice to replace the metallic points by tapering tubes, one of which is to lead the liquid (water, if that be preferred to oil), and the other is to give it exit by playing the part of a drain, or, better, by operating as a siphon. We shall thus have a liquid current between the two extremities of tubes arranged on a level with the water.

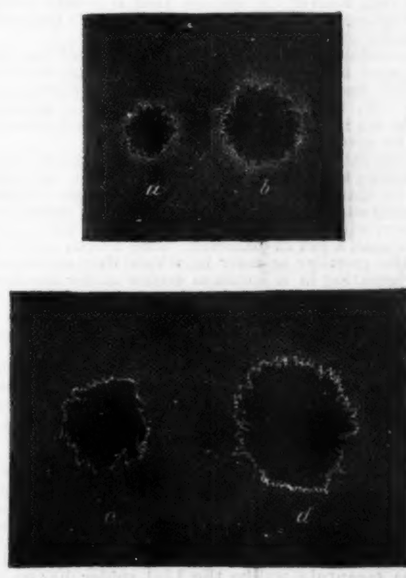


FIG. 23 AND 24.—IMITATION OF SOLAR CRATERIFORM PERFORATIONS.

If a floating powder or silk fibers be distributed over the surface, we shall, as soon as the apparatus begins to operate, observe the floating particles to hasten from every side and follow the direction of the current. Yet they will not remain stationary, but will be carried along by the current, and be continuously replaced by others that file along from every portion of the surface. Nevertheless, a polarization of the floating particles, and consequently of the liquid that serves as a vehicle, will occur. In order to better show the effect, the current might be produced intermittingly.

I might still further multiply these imitations, by hydrodynamic way, of electric phenomena, but those that precede seem to me to be sufficient for the object

I have had in view. I shall merely add a few words upon hydrodynamic imitation of various natural phenomena in which electricity plays a probable role, such as waterspouts (Figs. 17, 18, 19), comets' tails and fire balls (Figs. 20, 21, and 22), and solar crateriform perforations (Figs. 23 and 24), imitated electrically by Mr. G. Plante. The final conclusion that is evolved from all these varied results is that it is possible, through purely mechanical, hydraulic, or other means, to imitate, not only electro chemical rings, but also a very large number of fundamental or secondary electric and magnetic phenomena, and that the facts of analogy, especially between the two classes of electric and hydrodynamic phenomena, multiply the more and more in measure as we take the trouble to seek for them; and all these facts come to the support of that opinion which I have previously given, to wit: that electricity may be regarded as an undulatory or vibratory conveying motion of the universal ether, or of ponderable matter, or of both at the same time.

Finally, I shall add that this distinction between ponderable matter and matter regarded as imponderable at present is doubtless due merely to the imperfect state of our knowledge, and that sooner or later we shall reject it.—*C. Decharme, in La Lumiere Electrique.*

THE TARANTULA.

TARANTULA LYCOSA, or Aranea Tarantula, L., belongs, no doubt, to the great family of spiders, and resembles them in its habits and mode of living. It has a body generally about two or three inches long and an inch wide. The whole body, except the upper part of the thorax, is covered with long, brownish black hairs. The upper part of the thorax is protested by a horny substance, like that of beetles, in shape of a shield. The thorax occupies fully two-thirds of the whole body, and from the lower part of this the legs extend, ten in number, all coming out from a common center, and each containing six joints. The six legs in front are used for seizing their prey; the four behind—the longest—are used for locomotion, and on these the tarantula is able to stand upright. On the extremity of each leg is a sharp claw, resembling that of a cat. The tarantula, as stated, seizes its prey with its front legs, jumping on to it, and encircling it by all its legs.

Each side of the mouth, which is a triangular slit, is lined by reddish hairs; protruding from the upper jaw are two fangs, curving inwardly, about a quarter of an inch long, which serve the animal to hold its prey. These are horny, similar to those of beetles; the upper part of them is covered by hairs, and the lower part bare, and of a red color. These have an upward and downward movement similar to the claws of a wild animal. After embracing its prey, and introducing its fangs, the tarantula proceeds to suck out its juices pretty much as a boy would suck an orange.

The young tarantula has a white body entirely devoid of hairs; the abdomen is very soft, and filled with a gelatinous fluid, so that if a young tarantula is dropped on the floor, it smashes to pieces. It can be compared to a soft shell-crab.

The horny shield on the thorax is at first wanting, but it afterward forms, commencing to harden from the center.

Probably the secretions from the mouth are poisonous, and with them the tarantula paralyzes its prey. On the first third of the upper part of the thorax, just back of the fangs, are situated the eyes, eight in number. There are two in front and three on each side, in form of a triangle. If, however, you look at a live tarantula with the naked eye, you will see but two eyes, shining like tiny bits of bright silver; the others need the help of a magnifying glass to discern them. On the latter third of the upper part of the thorax is a round opening. For what use it is intended I do not know, but I am of the opinion that it is only found in the females. The female tarantula is much larger than the male.

The abdomen occupies about one-third of the whole body, and is of a roundish oblong shape, very large and soft, and in the full-grown animal is covered by hairs. On the lower part are found the mammary glands, six in number, used by the tarantula for spinning its nest.

At the extremity of the abdomen are two short legs, containing two joints, which turn upward, and terminate in claws, the same as the other legs. Between these are situated the genital organs. The tarantula, in common with most spiders, has a slender waist, a little larger than a pin in diameter. The length of its legs, and the peculiar manner in which they are situated, all originating in a common center under the thorax, enable it to jump a great distance. I have heard it stated on credible authority that it will jump six feet, and some persons have told me that they have seen it jump ten, but this is probably an exaggeration. This is a wonderful provision of nature to enable it to obtain its food, which consists of bugs, beetles, and worms. The common household spider catches its prey by means of a web, while the tarantula springs upon it.

The tarantula is very slow to bite, and I do not think would do so unless incautiously handled. The fangs are not used for biting merely, but for holding on to their prey. It possesses no sting as is commonly supposed. Its bite, though often referred to with a certain amount of superstition and poetic license, is seen to evince a depression entirely different from the dancing emotions ascribed to it by the people of Italy.

The tarantula, unlike the bird spider, has no black shining sting at the end of its legs, swollen like that of the scorpion. Neither does it have at the end of its abdomen two elongated glands which secrete a lacteal corrosive fluid which the animal is capable of ejecting against its enemy in order to render it insensible. Neither does it attack young birds or lizards, or snakes, as I am aware, neither inhabits trees, yet you will see, on comparing the tarantula I send you, that it is exactly like the bird spider figured in the April number of the SCIENTIFIC AMERICAN.

The tarantula inhabits old walls or holes in the ground. It rarely comes out of its hiding places in the day time, except when it rains, but prefers the night to do its hunting, when it is very apt to make unwelcome visits; but its dreadful appearance serves rather to frighten than do any harm.

The usual symptoms of its bite are depression, shivering, cold, clammy skin, and sunken countenance, which are to be counteracted by cauterizing with aqua ammonia and administering stimulants.

Although they are so numerous, I have seen but two cases of their bite during a number of years' residence in Mexico. Both of these persons complained of a feeling of numbness and depression, and both got well by use of stimulants. I have never known of a case of death from the bite of the tarantula. However, a friend of mine tells me that he knew of a horse that was killed by the bite of one, while grazing. It is strange that if they are so dangerous no more persons are bitten, as the general custom here, during warm weather is to sleep out of doors on the ground. A few nights since, while lying on the floor of my room, I killed eight tarantulas that were crawling about.

The nest of the tarantula is very curious, and well worthy of study. It is round, from one to two feet long, about an inch in diameter, and is woven of a material resembling the cocoon of a caterpillar. On the inside it is perfectly smooth, and in shape of the finger of a kid glove. It has a valvular opening, or door, made of the same material as the nest, which opens and shuts by means of a hinge. When the door is shut it closes so perfectly that no entrance can be effected from the outside without lifting it, neither can the rain enter. The nest is made in the ground, and runs perpendicularly or in a slanting direction, and serves the tarantula, not only as a home, but also as a deposit for its eggs, and for rearing its young, where they can be safe from interference. These nests sometimes have one or more divisions, or tunnels, branching off from the main nest, in each of which will be found generally a young tarantula. The tarantula spins no web, as does the common household spider, but probably forms the nest from secretions of the mouth and the mammary glands. On opening one of these nests, I found at the bottom a collection of remains of dead bugs and beetles, and on the top a young half-grown tarantula. The same I found the case on opening other nests; I never found more than one, or, at the most, two tarantulas. The young tarantula is a helpless little creature, and cannot walk about, but remains in the bottom of the nest, where it is fed by the mother, who brings it bugs and beetles, and drops them into the nest.

It is generally supposed that the tarantula lays a great number of eggs and carries them about in a bag, as the common household spider does, but this is a mistake; the tarantula lays but two eggs; these persons have mistaken a large black spider, which weaves a web, for the tarantula.

On the back of a female tarantula I discovered, by means of a magnifying glass, near to the opening on the back before mentioned, two small, white, oval bodies, which I have no doubt were eggs; besides, as before stated, on opening the nests, but one or, at the most, two tarantulas are found.

It is a mystery to me what becomes of so many young tarantulas, if the tarantula lays so many eggs as stated. Of those that believe in this theory, some state that the strongest tarantula eats up the rest, on the principle of the survival of the fittest; others that the grown tarantula devours all its young, leaving but one pair, a male and a female, and others still, that they are devoured by their numerous enemies.

That they do devour one another, I can certify from personal observation. I placed a full-grown tarantula and a small one together in a pasteboard box, and the larger tarantula at once seized the smaller one, and in a short time had half devoured it.

There is a large wasp with a red body (Pompilus formosus), called "Chupahuesos," which pounces on the tarantula, stinging it, causing instant death; it then buries it, and covers it carefully with dirt. To an ordinary observer this seems a strange action on the part of the wasp, but it is a wise provision of nature, enabling it to produce its young. If you dig up the tarantula precisely twenty-two days afterward, you will find it swarming with young wasps. The wasp deposits its eggs in the body of the tarantula, and the larvæ live on its tender flesh.

The *Faisan*, or pheasant, considers the tarantula as a peculiar delicacy, and devours them raw, without any repugnance. With its long bill it fishes them out of their holes. This pheasant is about the size of a two months' old chicken, of a light brown color, spotted with white, large red eyes, and has a crest on its head, has a long bill, and its feet are provided with long, sharp claws. It runs very fast, but does not fly. It does not hesitate to attack the rattlesnake, alighting on its head and killing it by a single blow.

CHARLES WINSLOW.

Guerrero, Tamaulipas, Mexico.

[An illustration of the California tarantula and its nest will be found in the SCIENTIFIC AMERICAN of July 19, 1884.—ED.]

MISSOURI CREMATORY ASSOCIATION.

THERE is an increasing tendency in various parts of our country to discard the long practiced earth burial of the dead, and to adopt cremation. Minds which at first shrank from the thought of burning the remains of a dear one have come to see that in point of fact it is far less revolting to contemplate the idea of the immediate transformation of such a loved form into volatile gases and clean, white ashes by the agency of intense heat, rather than that of the loathsome change which it undergoes in the ordinary process of slow putrefaction when buried in the earth.

This is well expressed in the prospectus of the Missouri Crematory Association:

"Let it be clearly and fully understood that cremation is only a safe, cleanly, expeditious, and economical method of facilitating nature's work; that it is simply an accelerated decomposition, and that precisely the same result—the oxidation of the body—finally obtains, whatever the process, whether among the gloomy horrors and putrescence of the grave or in the rosy glow of the crematorium. Surely, when this is understood, a rational people cannot long hesitate which to choose. . . . Cremation is effected in a superheated air-chamber, which allows no contact of flame or fuel with the body, while all the gases and volatile product of combustion are completely regenerated and rendered innocuous and odorless before being liberated.

"The body, covered with a pall, is placed in a catafalque in the chapel or reception hall, whence it descends noiselessly by means of an elevator to the incinerating chamber. This, by means of superheated air, has been raised to a white heat of about 2,000 degrees Fahrenheit. When opened to receive the body, the in-rushing cold air cools this chamber to a delicate rose tint; and the body, after an hour's bath of rosy light, is completely decomposed, nothing remaining but a few pounds (about four cent. of the original weight) of clean, pure, pearly ashes, which are taken out and put in an urn of terra-cotta, marble, or other suitable material, and placed in a niche of the columbarium, or delivered to the friends, to be disposed of as they may desire."

It is estimated that the cost of incineration will be ten to twenty-five dollars. An urn, a niche in the columbarium, and a tablet, may cost an equal additional amount, making the total cost for such a disposal of a human body, apart from the expenses of removing the body from home to the crematory, about fifty dollars. A crematory association has been formed in St. Louis, and already numbers three hundred members, among whom are included several physicians.

A WATT ENGINE.

A "sun and planet" engine, designed by James Watt, is still used in a London brewery to perform the same duty for which it was constructed in 1785. Some alterations have increased its power, but the principal parts remain as they were first manufactured. A tablet on the engine gives an account of its invention and history.

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